

May 11, 1959

Aviation Week

Including Space Technology

How Soviets
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USAF-Martin Titan A-1



**You'll wonder
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*(Voi-Shan engineered a weight saving averaging 22% on their **weight/master** anchor nut.)*

Voi-Shan's introduction of **weight/master** anchor nuts to the fastening field is the result of a new design concept that meets the requirements of the industry while providing the utmost in saving.

weight/master 



weight/master's Balanced Design has a readily recognized form shape. Excessive metal has been removed without sacrificing full performance.

Voi-Shan has the **weight/master** readily available in the single lug, two lug, and corner type anchor nuts in five sizes: 4-40 through 1 1/4-20.

The chart shows Voi-Shan **weight/master** part numbers with the applicable NAS numbers.

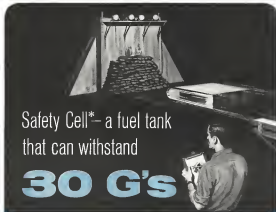
For information on these and other **weight/master** nuts, write to:

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VOI-SHAN MANUFACTURING COMPANY
8463 Higuera Street Culver City, California

VOI PART #	NAS/NAS PART #
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that can withstand

30 G's

THE PROBLEM: how to control aviation fuel during high impact conditions so that instant incense vaporized combustion can be prevented.

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THE SIGNIFICANCE: personnel and property protection against full vapor combustion for beyond any type previously obtainable.

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Ten-Pound Gun Four-Ton Pull

You Get MORE POWER—Less Weight with the New CHERRY G-85 Lockbolt Gun

The new Cherry G-85 lockbolt gun is designed to give you maximum pulling power with less weight. Its simplified rugged construction ensures low maintenance costs. The gun weighs only 16.5 pounds, which reduces operator fatigue.

No special air supply is required with this lightweight gun, because it develops that high capacity at normal line pressures.

As the leader in the field of special aircraft fasteners, Cherry Research

and Development department has produced this new lightweight, high capacity gun to increase the efficiency of installing lockbolts.* The G-85 gun may be adapted for setting standard steel, metal, aluminum and carbon steel Cherry blind rivets.

For information on the new Cherry G-85 gun write Townsend Company, Cherry Rivet Division, Post Office Box 5187-N, Santa Ana, California.

*Special G-85-1000 model will install 1000 lb. pull 1/4" diameter F-100 and F-4 bolts.

CHERRY RIVET DIVISION

SANTA ANA, CALIFORNIA

Townsend Company

ESTABLISHED 1934, A NEW BRIDGTON, PA.

AVIATION CALENDAR

(Continued from page 5)

- Northwestern Science Meet, DePue County Airport, Poughkeepsie, N. Y.
- June 13-17—Third Annual Scientific Conference on Vacuum Metallurgy, New York University College of Engineering, Des Plaines Heights, Bronx, N. Y.
- June 18-19—National Symposium, Institute of Radio Engineers' Professional Group on Microwave Theory & Technology, Harvard University, Cambridge, Mass.
- June 24-Third National Conference, Institute of Radio Engineers' Professional Group on Production Techniques, Villa Hotel, San Mateo, Calif.
- June 26—Annual Meeting of the Aeronautical Society of America, Sheraton Hotel, Washington, D. C.
- June 26-10th Annual Maintenance & Operations Meeting, Reading Aviation Services, Inc., Municipal Airport, Reading, Pa.
- June 28-Industry Metals and Space Conference, Sheraton Cadillac Hotel, Detroit, Mich.
- June 31-Second Annual Meeting and Aeronautical Exhibition, American Rocket Society, El Centro Hotel, San Diego, Calif.
- June 12-15—Third French International Air Show, Le Bourget, Paris, France.
- June 15-18—Scientific Meeting, American Society of Mechanical Engineers, Civic Club Plaza Hotel, St. Louis, Mo.
- June 18-19—National Summer Meeting, Institute of Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.
- June 23-26—Western Pacific General Meeting and Air Transportation Conference, American Institute of Aeronautics and Astronautics, Seattle, Wash.
- June 28-29—Third National Aviation Exhibition and Manufacturers' Assn. St. Francis Hotel, San Francisco, Calif.
- June 29-30—Second National Symposium, Nuclear Institute, Deane, Incorporated, Society of American Indian Falls, Idaho.
- June 30-July 1—Third National Conference on Military Electronics, Sheraton Park Hotel, Washington, D. C.
- June 30-July 1—Symposium on Physics—3rd National Properties Design and Application, Pennsylvania State University, University Park, Pa.
- July 1-14—U. S. National Science Congress, Union Ltd. Hotel, New York.
- July 14-18—All Western Transportation, Air Race from Los Angeles, Miss to Rochester, Wash. For information: All Western Transportation, Air Race, Inc., 1811 East Spring St., Long Beach 5, Calif.
- July 30—Florida Annual Symposium on Computers and Data Processing, Davies Research Institute, Stanley Hotel, Boca Raton, Fla.
- Aug. 31—Sept. 5-19th Annual Congress International Association of Technical Aircraft House, Winkleyton, London.
- Sept. 7-10-19th Pan-American Flyer Display and Exhibition, Parks of British Aircraft Corporation, Pinner, Eng. land.
- Oct. 12-15-19th General Convention of the International Air Transport Assn., Tokyo, Japan.

**Hydromatics
FLO-BALL valves
form the heart
of the X-15**

Four FLO-BALL valves, controlling the combustion flow of LOX and ammonia, form the complete fuel metering package . . .
main propellant valve,
2nd stage igniter propellant,
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Only these space-age valves . . . could form the life-or-death heart of the X-15 . . . carrying America's first man into outer space!

Write for complete information on Hydromatics FLO-BALL valves . . . excelling in every major missile, aircraft, and ground support system.

Hydromatics, Inc.

Livingston, N. J.



The Bell HELL, Helicopter Trainer



Backstopping the Navy's striking power in the air are its helicopters and their pilots who perform missions ranging from plane guard to defense against the threat of enemy subs—and Bell is the helicopter that trains them all.

At Ellyson Field, the Navy's helicopter training center, Bells are used exclusively for primary training through solo flight by each of the more than 600 pilots graduated every year.

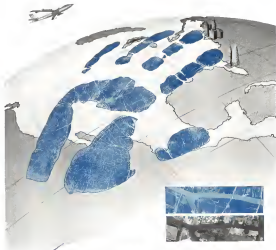
Regular trainees receive a standard 90-day course—pilots of flag rank get an intensive course lasting three weeks. And every last man-jack leaves Ellyson Field's HTG with a keen sense of pride in his newly-acquired "whiskeybird" wings.

Bell, too, is proud—for its contribution to the strength and versatility of the Navy, Bell is helping contribute to America's position as "guardian of the peace."

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**BELL
HELPS
TRAIN
THEM
ALL!**

BELL
HELICOPTER CORP.



INFRARED FINGERPRINTS

for reconnaissance, interpretation and prediction

Aerial reconnaissance systems of the future will depend on infrared detection and sensors for operation around the clock. Each surveillance target or object of military or geographic significance will have its own characteristic fingerprint in the infrared spectrum.

Related activities at Bendix Systems Division, backed by years of experience in these techniques, are developing important new approaches to the interpretation and prediction of infrared reconnaissance data.

Extensive flight test data are being analyzed and cataloged to provide the guide to infrared interpretation. Also, test results are being correlated with laboratory techniques to predict the response of sensors and synthesize the infrared pictures they will produce. Thus, it will be

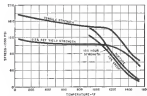
possible to plan sensors exactly as they will appear to the infrared observer.

Other related work includes target and background radiometric studies, detector studies, and infrared instrumentation for geophysical satellites, sensors, search, track, fire control, early warning, aerial intercept, collision warning, communications, imaging, horizon viewing, and infrared augmentation for target chasers. Progress in infrared research and development exemplifies Bendix leadership in "the systems of tomorrow." Major Programs include the AN/JAMQ-75 Weather Reconnaissance System and the Single air-to-air missile system. Inquiries are invited with respect to positions for better engineers and scientists.

Bendix Systems Division

AIR ARMS ALCOHOL





Graph shows high tensile, creep and rupture strength Incoloy "901" provides at 1000°-1400°F.

New standard alloy... "super" alloy properties!

In the 1000°-1400°F range, Incoloy "901" iron-nickel-chromium alloy has properties which match those of "super" alloys.

Its nominal composition is 40% nickel, 13% chromium, 2.40% titanium, 0.00% niobium. The balance iron.

Incoloy "901" alloy was especially developed for rocket and gas turbine components. This alloy provides high tensile, creep and rupture strength (see graph), good oxidation resistance and favorable expansion characteristics at elevated temperatures.

Solution treatment extends time-to-rupture

In bar stock, time-to-rupture for a given stress and temperature can be extended by a high temperature solution treatment before aging. Sheet is best formed in the annealed condition and aged by a short time (2 hr) treatment at 1400°F.

Other new high temperature alloys developed by Inco

In addition to Incoloy "901", Inco has developed four other high temperature alloys which deserve attention in missile design. They are: Inconel "713 C" nickel-chromium alloy, Inconel "700" age-hardenable nickel-cobalt-chromium alloy and Inconel "702" aluminum-containing nickel-chromium alloy. For basic data on all five, write to the address below.

*May be used in certain cases.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street



New York 2, N. Y.



U.S. Air Force's Thor

WESTERN GEAR MISSILE ASSIST

- TURBO-PUMP DRIVES
- THRUST CHAMBERS (SOLID)
- JET-VECTOR ACTUATORS AND KINGS
- NOZZLES, FINS AND FLOWERS
- WARNING DEVICES
- SURVIVOR AND SERVO AMPLIFIERS
- HIGH PRECISION FINE PITCH DRAGS
- GROUND SERVICE EQUIPMENT
- TEST FACILITY DRIVES

Why not take advantage of the complete engineering and manufacturing facilities offered by Western Gear for an expeditious, thoroughly reliable answer to your missile requirements in the electro-mechanical field?

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WESTERN GEAR CORPORATION

INCO NICKEL ALLOYS
NICKEL ALLOYS PERFORM BETTER LONGER



New concepts
in modular
micro-miniaturization...
by
Bulova



Put Bulova capability behind your program



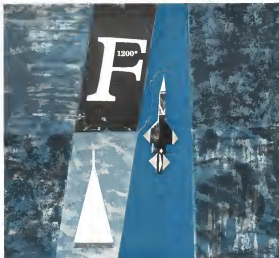
Bulova is implementing and showing new concepts in micro-miniaturization, high-density packaging and micro modular construction.

Bulova craftsmen, toolmaking and production facilities are geared to mass production with tolerances of less than .0007". Match making and quality control techniques provide definite savings in process assembly.

Experience in precision design, in precision manufacture, is the Bulova capability. Has been for over 80 years. For more information write—

Industrial & Defense Sales, Bulova, 22-23 Woodside Ave., Woodside 27, N.Y.

BULOVA



BRUNSWICK "SHOOTS" THE RADOME RANGE TO 1200° F

Brunswick makes a new breakthrough in the thermal barrier with newly developed non-metallic materials that boost the temperature tolerance of radomes and nose cones to 1000-1200°F for limited exposure periods—almost twice the previous level. This new advance in Brunswick's Strickland "B" Process of filament winding opens a new chapter in aircraft and missile designing.

New "SBF" filament winding results in the highest strength-to-weight ratios ever obtained in radomes and nose cones with significant weight savings over conventional structures. With unmatched electrical uniformity, Brunswick builds them to meet the tightest tolerances for dielectric constants and compound configurations. Brunswick offers full electronic testing facilities.

Brunswick radomes and nose cones now slice skyward on such supersonic aircraft as the advanced Canard F 104, on such missiles as the Boeing Boreo and Lockheed Q5. For details on Brunswick's leadership in research, development and testing, write: The Brunswick-Bulk-Collender Company, Defense Products Division, 1700 Messer St., Muskegon, Mich.



BRUNSWICK

MAKES YOUR IDEAS WORK



Great missile components—including rocket motors for the Minuteman—are being heat tested by Solar in the new furnace.

New Solar capability for giant space age components

THE LARGEST CONVENTIONAL atmosphere pit furnace in the nation is in operation at Solar. Capable of heat-treating and brazing assemblies of 9 ft. in diameter by 36 ft. in length, this furnace represents an important addition to Solar's

advanced weapon system capability. With years of active experience in producing aircraft and missile components—and as an industry leader in high-temperature technology—Solar is particularly qualified to help solve difficult

design and fabrication problems. Write to Dept. G-013, Solar Aircraft Company, San Diego 18, California.



ENGINEERS WANTED: Challenging projects, unlimited opportunities with Solar. Write today!

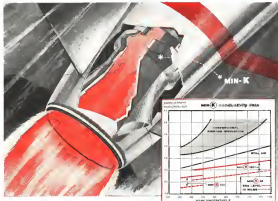


Chart compares MIN-K's thermal conductivity with conventional blown insulation and still air. Note that MIN-K's conductivity decreases with altitude.

Johns-Manville announces...

A scientific break-through in missile insulation!

New **MIN-K** has lower conductivity than still air—performs better the higher it flies

- Saves valuable space to boost fuel capacity and range
- Protects instrumentation more effectively to increase accuracy
- Offers lower thermal conductivity than any known insulating material
- New performing successfully in operational U.S. missiles

MIN-K is an exciting milestone of the new—*a scientific break-through!*

For in MIN-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation is effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range
With this new low in thermal conductiv-

ity (less than half that of the best blown insulation), MIN-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation... increases range by conserving space for greater fuel storage.

Insulates better the higher it flies
Unique with MIN-K is improved performance at altitude, for as thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, MIN-K's thermal conductivity is decreased by at

least 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—MIN-K solutions are precision-molded to any shape you specify—encased in high-temperature metal foil or laminated in reinforced plastics. MIN-K insulations include a wide variety of strengths, densities and temperature ranges.

For detailed information about MIN-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for written insulation brochure JN-153A.) In Canada, Port Credit, Ontario.

JOHNS-MANVILLE



PHILCO IS PEOPLE

From advanced research and development to mass production, installation and servicing of precision electronic products and systems, Philco is people. Here is a closely integrated organization of scientists, engineers, installers and service specialists, ready to meet any challenge for reliability of military, industrial and consumer electronics systems.

PHILCO IS FACILITIES

To meet the outstanding requirement of skilled and dedicated people, Philco has removed millions of dollars worth of scientific equipment in plants and laboratories from coast to coast. Philco facilities include the world's most advanced research laboratories, test facilities, specially equipped design and engineering labs, plus prototype and model shops, and the most advanced mass production facilities.

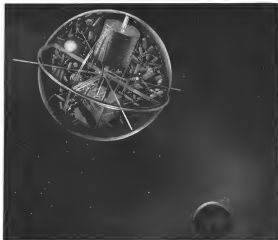


PHILCO IS CAPACITY



At Philco the world of tomorrow is NOW! Here are human resources, plus ultra-modern facilities, plus tremendous accumulated experience in research and development. Here too, an unlimited career opportunities in the fields of science and precision, weapons systems, A-1 Transistor computers, infrared, advanced radar techniques and communications systems. At Philco, versatility is the key to transcend capacity in advanced technology. Make Philco your prime source for prime contracts from development to delivery.

PHILCO
GOVERNMENT & INDUSTRIAL DIVISION
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Philadelphia 44, Pennsylvania



Meet temperature demands of the satellite age with the latest CDF laminates and tapes

Many new flame-retardant and high-temperature-resistant grades of CDF laminated plastics were developed specifically for the exacting service of space and satellite operation. Here are a few:

High-temperature structural parts. New CDF filled asbestos plastic laminates have successfully resisted exposure to temperatures of 3500°F for 6 to 10 seconds, 2500°F for 60 seconds, intermittent operation at 500°F, and continuous operation at 500°F, without loss of mechanical properties. Negligible dimensional and mechanical changes have been observed in dry or wet heat after prolonged exposure at 500° to 550°F.

Flame-retardant glass-base laminates. Inexpensive self-extinguishing properties characterize new CDF glass-base epoxy laminates for high-temperature printed circuit and other electronic applications. Typical properties: CDF Grade GH-384F8, which meets MIL-P-38177A, type GEL, exhibits ignition resistance of 150,000 milliseconds, and resistance of 350 seconds.

Flexible printed-circuit sheeting. CDF has developed special flexible grades of Di-Chlor® printed-circuit base, made with glass-reinforced duPont TEFLON TFE fluorocarbon resin, clad on one or both sides with electroplated copper.

Full CDF line. These heat-resistant specialties are only a few of the complete CDF line of electrical insulations, which includes Di-Chlor® Laminated Fibres/Di-Chlor® printed-circuit laminates/Colon® molded products/Marbond® resin products/flexile tapes of Nylon, Marbond®, and Bilsane rubber/DuPont® Valon® and Valon® resins impregnated fibre.

Enjoy the complete plastic-fabrication facilities of CDF.



CONTINENTAL-DIAMOND FIBRE
A DIVISION OF THE *duPont* COMPANY • NEWARK 15, NJ

EDISON

launch range computer
calculates distance
from aircraft to target—
automatically



Computer calculates where aircraft from aircraft to target in miles. Light indicator when aircraft is too close to target for missile launching.



Edison computer contains two control transformers, servo motor, transformer-magnetic amplifier, gas tube with slip clutch and logically lighted indicator with potentiometer read, all in a compact package weighing only 44 pounds.

New Edison range computer is a novel instrument used in air to ground release of guided missiles. Unit computes automatically the distance from the aircraft to a ground target. Pilot formerly had to perform this problem manually. With this new instrument, pilot guides missile on computer—and then after a 20 to 40 mile cruise at right angles to target, at end of run, indicates where distance to target in miles. If he is within proper range he may then release missile.

This range computer is another example of Edison's capability in research, design and production.

Thomas A. Edison Industries INSTRUMENT DIVISION

49 LAKEVIEW AVENUE, WEST ORANGE, N. J.

EDISON ENGINEERING OFFICES ARE LOCATED IN: BOSTON—BALTIMORE—BIRMINGHAM—CHICAGO—DALLAS—DAYTON—LOS ANGELES



WHO'S WHERE

In the Front Office

Donald W. Douglas, Jr., a director, Gen. and Arthur and Edna Corp., New York, N. Y.

Lawrence S. Cook, a director, Alcoa Manufacturing Co., Elmwood, Calif.

J. Vincent Moore, a director, Newark Corp., Millville, N. J.

Hugh S. Ferguson, president National Research Corp., Cambridge, Mass. Mr. Ferguson succeeds Richard S. Moore, now Director of Research and Development for the U. S. Army, Washington, D. C.

Maxwell G. Whitman, a vice president, Semiconductor Division, Halliburton Oil Refining Corp., and manager of the Division's new West Coast plant, El Monte, Calif.

D. F. C. Coates, vice president research, General Atomic Division of General Dynamics Corp., San Diego, Calif. Also appointed vice president R. B. Fay and G. A. Kohnen, Jr.

J. Douglas Early, vice president and in charge of the production, United States Steel Corp., Pittsburgh, Pa.

George Usher, vice president engineering, Bellman Electrical Products Corp., Willing, N. J., subsidiary of Electric Ship and Components of Annapolis.

Myron P. Ruchbach, vice president special products engineering, General Dynamics, Unimac Division, Van Nuys, Calif.

Joe Fox, vice president, Raven Electronics, Inc., Fort Worth, Texas.

Otto Staver has been appointed the first director of the National Radio Astronomy Observatory, Green Bank, W. Va.

Carl F. Schmidt, engineering director, Philco Safety Foundation, Inc., New York, N. Y.

Dr. John A. Stratton will be in charge of the 11th project of the Materials with Institute of Technology, Cambridge, Mass., on June 15.

Housers and Elections

Dr. C. S. Doorn, head of Massachusetts Institute of Technology's Department of Aeronautics and Astronautics, has been appointed chairman of the National Aeronautics Council, Washington, D. C.

K. F. Maule, vice president semiconductor division of General Electric, has been elected chairman of the Manufacturing Committee of the Aircraft Industries Association.

Mr. F. McCann, executive general manager of the defense division of Hughes Aircraft, was elected vice chairman.

(Continued on page 145)

INDUSTRY OBSERVER

Four industrial teams have just submitted bids to Ad Hoc for its new ground-based electronic intelligence data gathering and processing antenna known as 466L, which calls for expansion and integration of USAF's existing network for obtaining electronic intelligence. Bidders include teams headed by General Electric, Hughes Electronics, Radio Corp. of America and Thompson Radio Manufacturing.

Flight control and guidance system suitable for soft landing of an extra small payload on the moon is the objective of a design study contract recently awarded to Sperry Gyroscope Co. by Wright Air Development Center.

Supersonic control navigation system (SINS) for five of the Navy's new Polaris carrying submarines will be built by North American Aviation's Astronautics Division; two other Polaris submarines will use SINS built by Sperry Gyroscope. The two companies are bidding for subsequent Polaris submarine inertial guidance business.

General Electric and a team consisting of Canadian and Raytheon are the two top candidates for selection by Avco to develop its Mosler Stratosol air defense missile system if the Army is able to find sufficient funds to finance the program. Decision is expected before the end of the month.

Elimination of the full length longitudinal welded seam on large solid rocket motors is being obtained by General Electric at General Aircraft Co. Turbine Division through a development program they set out of tool steel. GE has a development contract for Minuteman cars using this process. The technique still hasn't reached the stage where GE can spin the whole case, so sections must be welded laterally. GE, however, hopes to reach the point where a complete, seamless case can be spun.

International Business Machines Corp. has won recognition to supply silicon digital computers for new tactical guidance system to be used on Titan intercontinental ballistic missile. Computer will work with ground-based platform to be supplied by AC Spark Plug Division of General Motors (N.Y. April 28, p. 34), using laser beam developed by Massachusetts Institute of Technology's Instrumentation Laboratory. USAF's Ballistic Missile Division and Space Technology Laboratories awarded recommendation by MIT's Dr. C. S. Draper that Titan guidance use a small digital computer where MIT had developed for that purpose.

General Electric's rocket engine section of the Aircraft Gas Turbine Division has a new laboratory project that is the laboratory increases yield strength of steel 100,000 psi. That is it can rise present yield strengths at 200,000-240,000 psi to 300,000-340,000 psi. The trade name of the process is Air-forming. Navy Bureau of Ordnance has supported the initial research.

Marlin Co. is doing research and development work on stable liquid propellant for possible use in advanced UAV. Other intercontinental missiles and space vehicles and for the Navy Bullpup air-to-surface missile.

Hughes Tool Corp., Culver City, Calif., is probing studies in both hybrid and solid rocket fuels.

Operations and maintenance costs of USAF's SAGE aircraft detection system will reach an estimated \$129.5 million for Fiscal 1960, according to Defense Comptroller W. J. McNell. SAGE system operations and maintenance costs totaled \$46 million in Fiscal 1955. Level off of annual costs is anticipated by Fiscal 1965 and probably will be in the area of \$160 million.

Ford 1966 defense budget requests for an additional 70 Boeing B-52H intercontinental jet bombers, powered by Pratt & Whitney J57 turbojet engines, being total orders and requests for the B52 is 712.



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Washington Roundup

Nuclear Plane Reversal? . . .

Wishy for Defense Department to score its long-standing opposition to faster development of a nuclear-powered aircraft is a political cause, to say the least, and the ground from under those who have criticized it for its delay.

First public hearings ever held on the aircraft nuclear program are scheduled to begin on Thursday before the energy and development subcommittee of the Joint Atomic Energy Committee, headed by Rep. Melvin Price (D-Ill.). Union Defense had finally agreed to Air Force proposals for a greatly increased program, the hearings were expected to have a showdown. As a consequence, Defense is now expected not only to approve the program but to announce its intention before the hearings begin. Chief opponent of faster development has been Deputy Defense Secretary Donald A. Quarles.

. . . Backing from McCane

Support for the concept of rapid development of nuclear aircraft programs also came last week from Atomic Energy Commission Chairman John A. McCone. Asked if he favored application of nuclear power to non-aircraft flight, he said he did not. But, he added that development of atomic powerplants for aircraft should "go forward as rapidly" as technology permits regardless of applications because "one always has become opposed to some as technical advances have been made. Whether the USAF failed to project a battleship with atomic energy is correct, will depend largely on timing," McCone said.

NASA Budget

Home Science and Astronautics Committee last week approved a Fiscal 1960 \$485 million authorization for National Aeronautics and Space Administration. This compares with \$484 million NASA had for the current fiscal 1959 run.

The committee cut \$4.7 million for an undesignated area to test high-energy solid and liquid rocket fuels. However, a \$5 million "raincoat" included in the measure could be used by NASA for this purpose. The total includes over \$111 million for research and development as compared with \$255 million in Fiscal 1959. The authorized funds must still be implemented with appropriations.

More Atlas Squadrons Asked

An Air Force proposal to boost the number of Constellation intercontinental ballistic missile squadrons from the presently planned one to a total of 16 or 17 is now before Defense Secretary Neil H. McElroy for approval.

As Force Secretary James Douglas told the Senate Appropriations Committee late last week, that five, six and seven squadrons would require an added \$278 million in the Fiscal 1960 budget and an extra \$508 million in Fiscal 1961. A single Atlas, he said, costs approximately \$2 million as compared with \$7 million for a Boeing B-52 jet bomber.

Secretary Douglas also told the committee that Air Force had hoped to keep alive the now canceled Fairchild Goose gyrojet-powered demonstrator, missile program. In request for \$113 million in Fiscal 1960 to support the program was removed from the budget after its submission to the Defense Department, Douglas said.

Other cuts made in Air Force budget requests deleted

in Douglas included \$234 million from the Constellation bomber program and \$305 million from the Republic F-105 fighter-bomber program.

Soviets View Mars . . .

Life on Mars, a subject of speculation for several centuries, came in for more rational speculation in Soviet Russia last week. It included:

• **Artificial satellites.** Professor I. Shklovsky, writing in *Kosmicheskiye Prilozheniya* and quoted by Moscow Radio, said he believed Phobos and Deimos, the very small moons circling close to the planet Mars, are artificial space stations hanging from 100 million tons and put into orbit as well as two to three billion tons of intelligent beings who had "achieved a high level of culture."

Within a period of only a few decades," he said, Phobos "has gone into orbit and half-decayed bodies should be as orbit fast as its speed had been constant," indicating it was now in, spending into the planet. Phobos is known to circle Mars in less time than it takes Mars to turn on its axis. It is the only one of the 31 known satellites in the solar system to do so.

• **Unhologous Martians.** Prof. Aleksandr Zaitsev was quoted by the newspaper *Vzrazh* as saying in an article that intelligent Martians were have developed artificial organs, ears, eyes and several other organs. He said they displayed diseases, he said, including those. A crash explosion in Solovki 50 years ago was caused by the growth and disintegration of a nuclear space ship, possibly from Mars, as another explosion was sighted on Mars two years ago. Martians are artificial satellites launched centuries ago. They presumably returned to Shklovsky's belief.

. . . U. S., the Sun

Moscow, U. S. William M. Stratton told the American Congressional Union that the sun has become 25% brighter over the past five years. The sun's heat output has been thought to be constant. The increase in brightness, presumably accompanied by an increase in heat, coincided with an increase in sun spot activity to the peak of the sun's 11 year cycle. Stratton is awaiting word to see whether the sun could be subject to solar flares.

Work, reported by Dr. Stratton and in more detail by H. L. Johnson and Roscoe Lincoln in the *Observatory Bulletin*—now done at Lowell Observatory and sponsored by Air Force. The same meeting was told by Dr. Roger Collet of the Bureau of Standards, Boulder, Colo., that the paper says have an assumption.

Russell Plan

Sen. Richard Russell (D-Ga.), chairman of the Senate Armed Services Committee, said last week that he would give Congress a positive vote on the selection of weapons through an advance review of proposed programs. The military services would be required to submit authorization for their procurement programs each year from House and Senate Armed Services Committees before sending them to Congress. Russell pointed out last week that military construction programs, which total less than \$2 billion a year, are now given over by the two annual services committees, subject to protest, while the weapons procurement programs which total over \$15 billion a year are not.

—Washington Staff

McElroy Predicts Limited Use for Nike

**Increasing reliance upon F-108, Bomarc foreseen;
Nike Hercules still invited at Senate hearings.**

By Katherine Johnson

Washington—Defense Secretary Neil McElroy invited Congress last week to cut funds requested for Army's Nike Hercules surface-to-air missiles and related facilities from the Fiscal 1968 defense budget.

At hearings of the Senate Appropriations Committee, McElroy said that as the threat of attack shifts to facilities equipped with "Hound Dog" type standoff antiaircraft missiles and then to intercontinental missiles, the U.S. will "eventually have and use Nike point defense and turn increasingly to the USAF North American F-108 March 3 long-range interceptors backed by new defense Boeing-Bomarc interceptors." He told the committee:

"The F-108 goes the farthest north."

Then, for missile purposes, it looks very much as if Bomarc with its range of about 300 to 500 mi range in the near future will have the greatest reach in the intercepter because it does have the ability to reach out."

"We push the interceptors as far as we can south and to the east. We then have a Bomarc capable, down from the intercepter area where we can have point defense protection that would be supplied in some degree by Canadian (Bomarc) Bomarc. A relatively small number of additional high priority target areas will be considered as further Nike sites."

Nine months ago, Congress told its Joint Defense Department to make a study on the proper mix of interceptors and air defense radar. (AW May 11, p. 21). Congress cut 20% from combined Bomarc and Nike contract funds and directed McElroy to determine what impact on such diversified area, which would cost an estimated 100 million will be capable of it this year."

The committee actually does have even further and actually has cut the entire contract of air defense sites and

of long-range missiles at the time of firing. Use of the system, he said in the interdepartmental Nike (AW Dec. 5, p. 31) "A number of such missiles circling the target would be able to detect the great bulk of host aircraft in a minute while being off."

McElroy and "This would appear much doubt the amount of ranging time available from the Ballistic Missile Site Warning System codes."

In the time the U.S. believes that the Soviet will be capable of launching a full-scale intercontinental ballistic missile attack, McElroy said, the B-57G's mission is expected to be able to provide that critical portion of warning which would enable our strategic forces to get off on their retaliation mission." (AW McElroy transcript)

• Boeing B-57G equipped with Pratt & Whitney JT-17 turbojet engines. It flies at 16 to 17,000 feet, faster than the B-57C which flew at a great improvement over the earlier models."

• First North American Bomarc air-to-air missiles will be turned in by the B-57G are scheduled to be in the hands of Strategic Air Command by the end of Fiscal 1968.

• The B-57's still can be converted again to carry a large part of the retaliation mission."

McElroy rejected the suggestion of Sen. Henry Dwyer (R-Ill.) that the Air Force should consider a new program he championed. "We can't get too far ahead," McElroy said. He added, however, that "it would be difficult to proceed at this point because this does not look in though it is something that can compare with our much talk enough on even of funds."

"I believe that if you could put up

missions, Senator Defense Secretary Charles E. Wilson attempted to write a part of this dispute in November of 1965 in opposing the "point" defense role in the Army and the broader "area" defense mission to USAF.

At one time, last year, it appeared that Air Force might have to give up its defense efforts to Army and consequently, that the Air Force would be left behind the Bomarc at the risk of being left to full of aerial interceptors, as help for a new of missile and improved interception. McElroy's testimony indicates he favors the latter.

'Difficult' Decision

The ongoing Nike-antimissile controversy within the Defense Department, McElroy said, "has been the most difficult matter we have had to deal with." He added:

"We have not done very well in making a decision" he told the committee. "As far as I am concerned, it would be better to have held our feet to the fire and forced us in connection with this budget."

The Defense Secretary also said that high-altitude nuclear tests last p. 51) have shown "that there would be a complication in the use of a defense system like Nike Zeus" anti-missile missile.

Total of \$190 million already has been invested in the Nike Zeus development program in Fiscal 1955 and 1959, and an additional \$100 million is earmarked for it in the Fiscal 1968 budget. In addition, McElroy said the Fiscal 1968 budget includes \$130 million "for research work on still more advanced concepts for missile defense." The entire cost of Nike Zeus, he said, will be paid by the Pacific Missile Range, Pt. Mugu, Calif.

McElroy and there is "considerable expectation of success" in the development of a system of missiles which would be capable of detecting the fir

Kwajalein Test Units

Washington—Army Corps of Engineers contracts an additional \$1.4 million work for construction of Nike Zeus test units which would test facilities on Kwajalein at the Pacific Ocean. Experimental missiles and support equipment for the test program already have been provided.

Units will be first at targets launched from the Pacific Missile Range at California. Construction at Kwajalein will be done on part of a Navy site that has been declared in excess of current needs. The units will be placed at the Fugate's Pacific Ocean Division at Honolulu. Initial equipment for the unit is expected to be about \$1,000,000, including some 40 satellites provided.

a nuclear powered aircraft which was really not a practical, reliable instrument for performing some sort of action or action mission, that it would be very easily pointed out. "By the current narrative scenario, and I do not think that such a country would do anything more than business some sort of launching stock. "We are not aware of the technological advantages which might accrue to the nation which first has a true nuclear powered aircraft."

In testimony late last week, Air Force Secretary James Douglas told the committee that an ad hoc panel headed by Dr. Clifford C. Francis, chairman of Ballistic Research and former Assistant Secretary of Defense for Research and Development has recommended that development and deployment of the Bomarc be expedited.

The panel, formed as the request of Deputy Defense Secretary Donald A. Quarles in December, issued its report two weeks ago. Secretary Douglas said the report was "emphatic in its recommendation that our initial deployment of the Bomarc B should not be held up, in fact, expedited."

Douglas, who told the committee that the Air Force had no hand in calling for formation of the ad hoc panel, and USAF's Fiscal 1968 budget requests were under consideration and for approximately \$147 million for 19 Bomarc sites. Original Air Force request submitted to the Defense Department, he said, was about \$160 million, higher than the final figure submitted to Congress.

Boeing and Lockheed Report Earnings Drop

Write-offs on commercial airlines continued to loom as a factor in lower first quarter earnings reported by Boeing Airplane Co. and Lockheed Aircraft Corp., but changes in military programs also are important to Boeing, which showed the steepest decline.

In earnings, an index of \$10,000,493, was \$1,590,771 or 20 cents a share. This was a drop from earnings of \$6,499,200 to \$1.20 a share on earnings of \$4,111,648 for the first quarter of 1967.

Boeing had earlier predicted these declines, stating also from increases in fixed price contracts on the B-57G and Bomarc programs. Commercial write-offs for the 707 jet transport program totaled \$2,600,000, less than a share a year ago.

Boeing's 1967 sales of \$1,282 million to \$956 million.

Other financial reports:

• Thompson-Hawthorne, which reported first quarter sales increased 5% to \$91,201,841 with earnings of \$2,385,704 or 31 cents a share. This was



First Drawing of Tartar Shows Comparative Size

First drawing of Navy Bureau of Ordnance Tartar surface-to-air missile shows size in comparison with Titan 404, shown. Drawing of General Electric Tartar and Applied Physics Laboratory's Tartar gun construction. Tartar is a solid propellant, dual thrust rocket with 30 mi range designed for use against destroyers and cruisers. The larger Titan is about 18 ft long and weighs 1.5 tons. Tartar MK75 fire control director below is being prepared for testing at General Electric Ordnance Department. The unit is designed to track long-range targets.



\$64,800 in the first quarter, but earnings of \$4,112,000 or 61 cents a share were down from \$1,076,000 or 56 cents a share a year ago.

Boeing's 1967 sales of \$1,282 million to \$956 million.

Other financial reports:

• Thompson-Hawthorne, which reported first quarter sales increased 5% to \$91,201,841 with earnings of \$2,385,704 or 31 cents a share. This was

an increase from last year's quarterly figure of \$2,028,000 or 61 cents a share.

The company also is actively studying separation of its subsidiaries, Sperry Technology Laboratories.

• The American World Aircraft, which is rising prices of airline stocks, (AW May 4, p. 34), sold stockholders to approve increase of \$30 million in convertible debentures to finance further jet aircraft acquisition.

Jets Control Titan Nose Cone's Attitude



TITAN environmental ballistic missile test nose cone effects heating mechanism in highly polished forward section, which is shielded steel coated with nickel. Nose cone has just completed its final structural testing prior to shipment from Aero Research Corp. plant. Waste structure around after portion of nose cone is part of the packing mechanism used during movement within the plant for handling and to prevent damage. Instrumentation used by electronic tests are still installed. Aero now is studying vibration type events before in a more advanced nose cone program.

First type of Aero Research Corp. test and recently nose cone to be delivered to the Air Force is shown here during its fabrication test program at Aero. Specially designed for use with the Air Force-Martin Titan atmospheric ballistic missile, the nose cone is equipped with an attitude control device called DARAC (Directed Aerodynamic Righting Attitude Control).

The DARAC system does not operate until the nose cone reaches about 300,000 ft. during its ascent.

At this altitude where the air density is large enough for normal aerodynamic forces to begin to act on the vehicle, DARAC is activated to keep the missile from tumbling or rotating uncontrollably at large magnitude. Sensing such motion in DARAC permits determine angular accelerations and the attitude control system operated by these sensors consists of four gas jets. The jets are located 90 deg. apart on the outer end of the nose cone.

Aero's portion of the test program for this test and, perhaps has been completed, and the company is now engaged in more advanced nose cone work. Additional type events badly are being studied in this program. Aero also has participated in the Air Force recently test program using the Titan-Able model at a test vehicle.

Full-scale flight tests of this nose cone and others planned for the Titan probably will not be made for some time. Tests made at the Air Force Ballistic Missile Test Center, Cape Canaveral, Fla., have just passed through the A series. This series was originally intended to test structural integrity, not step powerplant and the aerodynamic.

Superior tests also were pushed into the first phase after the initial shot proved more successful than predicted. The separation procedure employed in these tests consisted of explosive bolts and the General Central JATO bottles on the 77 ft. diameter second stage. The JATO rockets pushed the second stage forward rather than having retro-rockets push the first stage backward as has been done on most U.S. military missiles. It has not yet been decided whether to use this procedure on the operational missile.

Instrumentation during separation included a series of sensors inside the missile which were played out as the two stages moved apart. As the rocket was begun to move, they sensed telemetry events which then give a picture to the ground of the rate of separation and several other parameters.

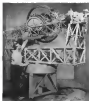
Next phase of the test program, the B series is now under way, with the first firing scheduled within a month.



DARAC (Directed Aerodynamic Righting Attitude Control) system is mounted on a Colby shaker (right) and is instrumented for the test program (left). DARAC mechanism is mounted on the outside of the large cylinder and a thermodynamic weapon model is located inside. Large diameter tubes extending the compass assembly are first born for the gas jets which are activated by DARAC. Small side vanes which measure angular velocity are the pointed sensors used by DARAC to keep the nose cone at the proper attitude.



LOW TEMPERATURE tests of DARAC unit are started at Aero laboratory. Performance tests of the complete unit are completed in the production rig below. Actual in-flight motions of the nose cone can be simulated.



NOSE CONE unit on small transport dolly before undergoing tests on the Colby shaker in the background. Struts members of the vehicle's telemetry system are indicated by the thick arrows, otherwise operational would extend and have the system. One of the four gas jets used for attitude control is shown by the white arrow. Three removable heating legs are attached to after end of the nose cone.

Maintenance Budget Forces Cuts

Washington—Fiscal 1966 budget of \$10.5 billion for operations and maintenance will provide for only a meager amount of what the military services require to perform assigned tasks, witnesses have told the House Defense Appropriations Subcommittee.

Although the 1966 figure represents an increase of \$206 million over fiscal 1959, including supplemental requests, increased costs of operations and maintenance will force (or threaten) programs to be scaled to fund high priority projects. Of the total amount, \$1.6 billion in Air Force obligations for operations and maintenance are estimated at \$4.2 billion, an increase over 1959, after \$5.018 billion, a decrease from 1959, and Navy \$2.5 billion, an increase.

Witnesses for all three services would believe the amount budgeted would prevent them to remain in a state of constant readiness, but to do this however it will require that operations be conducted on a highly selective basis.

Testimony Highlights

Highlights of other testimony given before the subcommittee are:

- **Flying hours program** for both Air Force and Navy will decrease in fiscal 1960 from the last fiscal year, as well as aircraft inventories. However, Army flying hours and inventory will increase. The Air Force active aircraft at 22,775, decreased in 1959, as did the Navy 19,922 (operating aircraft 18,000) by

the end of 1960. Flying hours will decrease during the next period from 7.7 million to 6.5 million. The Navy active aircraft inventory at 10,513 in 1958 will increase to 9,117 (operating aircraft 7,290), while flying hours will drop from 7.5 million to 5.2 million. The Army aircraft inventory will increase from 5,827 in 1958 to 5,345 in 1960 with a higher concentration of helicopters. Flying hours program will increase from 1.3 million to 1.9 million.

• **Air Force** in 1960 estimates a combined total of an active and reserve aircraft and related equipment overhaul program of about \$721 million. \$27 million less than the 1959 program. The Air Force overhaul program for an aircraft and related equipment for 1960 will be \$275 million, about the same as in 1959.

- **Army** has a backlog of overhaul work on non-replaceable tank components at portable equipment of \$3,301 million at the end of fiscal 1958, \$1,270 million at end of fiscal 1959 and by the end of fiscal 1960 it will be \$1,310 million.
- **Maintenance work** at installations will increase in fiscal 1960, but will not be undertaken, but which will not have been started by the end of the fiscal year will total more than \$780 million for all services.

• **Air Force** and that area with as or even lower housing of an aircraft, some of the facilities would have to remain in the ground because of insufficient refueling capability at the present time.

- **In the day-to-day operation** of high performance aircraft, the Air Force, having the most and the second largest inventory, cannot bring air-frame structures. Structural failure has been noted on several occasions 144th.
- **Overall new combat** resources of the Air Force's new aircraft structure (SAR) 20% by the end of fiscal 1970, and the force standing on maintenance alert will have been doubled.

- **Reorganization of Air Research Service** has resulted in slowing the local service mission responsibility, which previously had been performed by tactical group units, to individual air base. Helicopters assigned to this unit are now on 7-day standby alert to perform rescue missions within 100 miles of the air base instead of flying regular patrols.

- **Commercial contract support** will normally be required for greater missile and ground support equipment and the missile program studies and the Air Force gives additional support. As an example of the increased workload in missiles, the Air Force had fiscal 1959 requirement for ballistic missile development research estimated at \$5.7 million for Thor, Atlas and Jupiter

the fiscal 1960, it will jump \$13.1 million to \$16.5 million.

- **To date**, 80% of Air Force aircraft have been equipped with Titan missiles. By the end of July 1 of the year, 92% will be equipped and, as of July 1, 1960, a total of 94% will be equipped. Present policy is to have all Air Force aircraft completely equipped with Titans by 1967.

- **Loss of space** in keeping about 85% of the Navy's aircraft grounded. A Navy spokesman said the problem was more one of distribution and proper program than lack of funds.

• **Naval aviation** is a combination of a continuous airborne alert to protect its own forces limited, it said, sustained combat readiness and maximum ability to be in the air as needed directly maintained by maintaining in status to an aircraft and related equipment, about half of its fleet at sea at all times.

Navy Official Designed To Boost R&D Role

Washington—Navy last week formally established the office of Deputy Chief of Naval Operations for Research and Development. The new office, which will shepherd Navy weapons in civilian form through development, test and evaluation activities to succeed the Interagency Office of Assistant Chief of Naval Operations for Research and Development.

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Establishment of the new post was one of the major recommendations made by an eight-man committee headed by Under Secretary William B. Franke, which called for a major strengthening of the Navy's research structure (AWM) Mar. 30, p. 40.

At of late last week, however, the one-off report, which also proposed the creation of the Bureau of Aeronautics and the Bureau of Naval Weapons, a new Bureau of Naval Weapons had not been formally approved by outgoing Navy Secretary Thomas S. Gates, who originally had been scheduled to get the report approved by May 1, will be succeeded in the new task by Under Secretary Francis, primary author of the reorganization report.

AMC Awards JPS Follow-on Contract

New York—Follow-on contracts to follow \$29.5 million have been awarded General Electric Co. by Air Materiel Command for the development of the JPS tailcoat, scheduled to power the North American B-70 and F-106.

Space Technology

Pioneer IV Data Alters Van Allen Theory

Washington—Pioneer IV data confirms a long-held theory, launched last May, that showed a vastly different picture of the two natural belts of radiation that surround the earth than was obtained from Pioneer III or from data of Pioneer IV, according to the James Van Allen, the scientist for whom the belts were named.

Pioneer IV passed through the outer radiation belt about six days after a major solar disturbance. At that time the belt was found to extend more than 50,000 mi into space, about 20,000 mi farther from the earth's surface than the upper limit measured by Pioneer III in 1959.

Speaking before a symposium on "Problems in Space Exploration" Dr. Van Allen said that he tentatively suggested that charged particles emitted by the sun during solar disturbances are piled up and increased the total number of charged particles trapped at the outer radiation belt.

The report was held under the joint sponsorship of the National Academy of Sciences, the National Aeronautics and Space Administration and the American Physical Society.

Results of a preliminary analysis of the radiation data gathered by Pioneer IV are:

- **Radiation belts.** The structure of the two radiation belts around the earth as shown by Pioneer III and Explorer IV is confirmed by Pioneer IV.
- **Disturbances.** The outer radiation belt extended to 52,230 mi from the surface of the earth—18,750 mi farther than was indicated by Pioneer III on Dec. 6.
- **The increased total number of trapped particles** was more than three times that found in December.
- **Solar disturbance.** The flight of Pioneer IV was preceded on Feb. 23 by occurrence of a major magnetic disturbance, on Feb. 24, a solar flare occurred, replenished and increased the total number of trapped particles in the outer radiation belt.
- **Outer belt.** A detailed radiation counter on Pioneer IV showed that the outer radiation core contained particles mostly highly penetrating radiation. Relatively high-energy was absorbed by lead shielding 0.15 in. thick.
- **Outer belt.** Radiation in the outer radiation belt was almost completely absorbed by the shielding, tentatively indicating that the two zones are quite different.

Dr. Van Allen suggested that this

supports the hypothesis that the outer zone is the outer belt consists primarily of deep penetration of neutrons emerging from the earth's atmosphere, and that particles in the outer zone are primarily due to solar gas that is at much lower energy range. Other findings:

- **Counters.** Good measurements of the structure of the outer zone, cosmic radiation were received out to 70,000 mi from the earth's surface.
- **Inner zone.** Pioneer IV data reflects about 37,500 mi of the inner zone and showed no change in the intensity of radiation being measured at that distance. The magnetic influence of the sun's disturbance is not expected to reflect this far from the inner surface.
- **Interplanetary measurements.** Beyond 52,230 mi, and during about 25 hr of observation, no fluctuations in radiation were observed that were beyond statistical expectations.

The statistical characteristics of the two Van Allen radiation belts as previously determined are:

- **Outer belt.** The outer radiation belt begins at an altitude of about 1,300 mi and extends to 1,000 mi, and is about 4,000 mi wide from earth to earth.
- **Inner belt.** The inner radiation belt begins at an altitude of about 6,000 mi and extends to approximately 210 mi, and is about 70,000 mi wide from north to south.

Highlights of other papers presented at the joint meeting, and at separate

meetings were:

- **Outer belt.** The outer radiation belt begins at an altitude of about 1,300 mi and extends to 1,000 mi, and is about 4,000 mi wide from earth to earth.
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meetings were:

Manned Space Tests

Washington—Flight in a manned space vehicle has been completed by the first manned space flight to be launched at the last annual Space Medicine Symposium to be sponsored by the Franklin Institute in Philadelphia on May 18.

Volunteers from the NER, Deacon, Mission control, and the Air Force Research Center, and a Langley Research Center winged vehicle and an Edwards' vehicle. Flight hours were 10.5 hours.

Pioneer IV data reflects about 37,500 mi of the inner zone and showed no change in the intensity of radiation being measured at that distance. The magnetic influence of the sun's disturbance is not expected to reflect this far from the inner surface.

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structure of the two satellite systems was:

- **Project Apollo.** Scientific findings of the Project Apollo experiment which tests low-orbit nuclear bombs were completed at an altitude of about 100 mi over the South Atlantic Ocean were described (p. 55).
- **Earth environment.** Observations on the geomagnetic field at great distances recorded by Pioneer 1 and Explorer 1, and observations of Space Technology Laboratories, Inc., indicated a highly irregular structure. At a distance of 10,000 mi, both the magnitude and direction of the field varied in a disordered manner. This irregularity is the result of the influence of ionized gases expanding in the sun with the geomagnetic field. Data obtained from 10,000 to 15,000 mi indicated that on the air of light ionized gases in the field did not decrease in the predicted manner.

Other members of the same laboratory group described the radiation measured by Pioneer 1 and II. Pioneer 1 and II measured more than 70,000 mi, and provided the first experimental evidence that the outer radiation belt discovered by Van Allen after geomagnetic storms. Pioneer II only reached a maximum altitude of 600 mi before approaching its target. After that had the advantage of providing data on a relatively flat trajectory at the lower edge of the outer radiation belt as it approached the equator.

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Official Asks Study of Deterrent Satellites

By Philip J. Klaus

Boston—The U.S. must study the feasibility of deterrent satellite weapon concepts, directed orbiting satellites which could be launched on command out of orbit against aerospace targets as the main Research Projects Agency said last week at a recent American Rocket Society conference here on cost-effective satellites.

Although space feasibility questions about this weapon concept must first be answered, including such things as accuracy, reliability, availability and cost, deterrent satellites pose to have unique advantages, the ASRA Group Board said.

Putting up one of the problems involved, the placing of satellites orbit, Board said that approximately 2,000 lbs of payload would be required to quickly change the inclination of the orbit of a 5,000 lb satellite by only 10 deg.

Board also said it may be possible to employ manned space stations equipped with maneuverable missiles as an alternative against enemy satellites outside attack.

Use of a small ion propulsion system

offer significant weight saving over chemical or gas jet propulsion for small size attitude stabilization and/or orbit changing. Harold Brown, of General Electric's Flight Propulsion Laboratory reported in a paper presented by Russell N. Edwards.

For example, he said, a small ion propulsion rocket could shift the orbit of a 1,500 lb satellite by 10 deg in approximately 70 to 700 hr with consumption of only 60 to 60 lb of fluorine or other ion engine propellant, Brown said.

Small Rockets

Based on both new studies under way at General Electric on a 5,000-watt vacuum ion motor, Brown predicted that small ion rockets could be used to use an satellite by 1981-82. Although later orbit times would limit most use of these early models to several hundred hours, Brown said that larger, liquid-fuel rockets could be in orbit by 1960-61.

The 5 lb ion motor new motor test employs sodium vapor generated under controlled pressure. Vapor passes through a large heated rectangular duct defining through heated sodium ion-discharge emitter surface where it is ionized. Ions are extracted by electric field and the beam is guided by focusing electric fields generated by a vacuum electrode and ion gun nozzle with an ion beam to hold a neutral (uncharged) plasma.

Using present design concepts, Brown said it is possible to produce 100-watt ion rocket with about 0.001 lb thrust and a specific impulse of 10,000 sec and an efficiency of 70 to 80% (efficiency is ratio of exhaust jet power to total electric power supplied). Device would consume approximately 1 lb of propellant during a year's operation. At lower specific impulse, efficiencies would be somewhat lower.

A 15 lb ion motor capable of producing approximately 0.1 lb thrust could provide specific impulse of about 10,000 sec with propellant consumption of approximately one pound per day. Furthermore, experiments with ion propulsion devices using helium gas have produced specific impulses up to 1,500 sec with thrust chamber efficiencies greater than 90%. M. G. Adams and Morton Green of Aerojet Rocket Laboratory reported and those suggests that even higher specific impulses are obtainable. Efficiencies of 85% were obtained at specific impulse values of about 5,000 lb. In offering an alternative geometry, it should be possible to obtain the same efficiency at higher specific impulses, the Aero scientists said.

Major Effects
Three major effects which give least range of efficient operation of neutral plasma devices of this type, according to Adams and Green, are:
• **Power-line losses in vacuums.** When gas is heated above about 5,000K, some of that heat energy goes into dissociation of molecules into atoms as ions leaving electrons away from atoms. When gas is cooled as it expands through a nozzle, this energy is lost and does not appear as kinetic energy—unless recombination occurs before gas leaves the nozzle.
• **Heat losses to chamber walls.** This heat loss is severe because of an enormous heat loss in the walls, reducing the overall efficiency.
• **Electrode surface losses.** As specific impulse increases, the higher gas temperatures result in strongly increased electrode conductivity at the gas, producing increased mode heating. The electrode power consumed as waste heating increases over all efficiency.

Other areas which require further research include cathode emission rates, ion instabilities, transpo-

nan coating and ion-outlet cooling system design and heat dissipation from losses in process in the nozzle which would reduce energy lost in saturation and in some range of electron operation.

New standard atmosphere, known as the 1959 ARDC Model Atmosphere, based upon recent data obtained from rockets and sounding balloons, was prepared by Dr. R. A. Massman, Chief Physics Corporation of America. "Minor" changes were made on the staff of Air Force's Cambridge Research Center's Geophysics Directorate.

Greater Density

In the new model, pressure and density values are approximately half those of the 1956 ARDC Model Atmosphere at 100 to 110 km, and the 1975 values are about 15 percent greater (below) than the old model at altitudes of 500 km, Massman reported.

Molecular scale temperatures in the new model are 10% higher than the 1976 values in the 80 to 90 km region, but the temperature gradient between 100 and 160 km is 70K per km—about double the value used in the 1956 model. The molecular scale temperatures of the new model are almost twice those of the 1956 model at the 180 to 300 km region, Massman reported.

Molecular weights used in the 1956 model may be "considerably in error," particularly between 80 and 300 km, Massman said, based upon data obtained from recent sounding rockets.

Use of aerodynamic stabilization of vehicles at altitude for total altitudes of less than 300 km appears feasible despite the near-vacuum conditions, according to a report by John K. Wall of Douglas Aircraft Co. Aerodynamic stabilization maneuvers could be achieved by dragging in this atmosphere coated gliders sphere attached behind the satellite, or by dragging a device resembling a huge hair like.

Oscillation Periods

Wall estimated that the aerodynamic stabilization maneuvers produced are accordingly small and would result in oscillation periods of several hundred seconds, but this might not pose a major problem in terms of the actual orbit life span of a given satellite.

For a 700 lb satellite orbiting at 230-180 km altitude, a 20 lb detector balloon would produce a stable relation with an oscillation period of about 100 sec, Wall estimated. A hair like wire stabilizer measuring approx. 10 ft by 23 ft as a tube would provide similar performance. If these devices proved feasible, the long-term sleeping mechanisms could be employed to couple the balloon or hair line to the satellite, according to the speaker.

Structural Modifications on B-47 Boost Active Life by 3,000 hr.

By J. S. Betts, Jr.

Washington—All operational Boeing B-47 bombers have had their useful life extended for approximately 3,000 hr, or between six and 10 years in normal service with the Strategic Air Command.

That Air Force extension based upon structural modifications made after the aircraft was subjected to vibration tests to determine its fatigue life. The need for modification to the B-47 was clear long before the fatigue tests were completed, and the exact benefit of the modifications could be determined. During conversations between early in March, Maj Gen A. G. Hewitt, then Chief of the Strategic Air Command, engineering, reported only that modifications were being made before the tests were completed. The test was then begun to determine exactly how long the modified aircraft would hold together.

The group at Boeing-Wichita was slightly ahead of the other test groups, and its aircraft experienced the first major failure. The aircraft actually flew two years after the start of its fatigue tests to make the modification, all of the tests were resumed, and on the basis of the data gathered since that time the Air Force, after applying suitable safety factors, estimates that all of its modified B-47s will not fail at least 3,000 hr beyond their previous life-time (B-47s), which were among the last of the line when production ended two years ago, have considerably more than 3,000 hr of useful life ahead.

Comparative behavior on the B-47 structural life tests brought out the fact that the aircraft so large as the LARS maneuver to deliver bombs at low level. This required the bombs to approach at low level and at near maximum speed and then execute an immediate turn. The bomb was released some three during the turn.

Gen. Hewitt said that the use of this LARS maneuver, and which the B-47 was not specifically designed to use, was contributing factor in the fatigue failure on the aircraft Maj Gen M. A. Pittman, USAF director of operations in the office of the Deputy Chief of Staff Operations, said which the LARS maneuver has been discarded on the B-47s, other effects means of delivering bombs at low level have been developed.

Value of the test extends beyond the discovery of atmospheric type failures which probably will occur during some period in the life of the aircraft, but the longer failure on the B-47. The tests also aid in ordering maintenance plans and spare parts purchase. This has benefited the B-52 program because the

operation of 12,000 flying hours will have been logged during the fatigue tests before the aircraft was released. It received 10,000 hr. Another major benefit of the tests is the check, this give an increased design confidence for long fatigue life. Considerable revision of the specifications has resulted from the B-47 tests.

Validity and repeatability of the dynamic loading tests was illustrated by the fact that three separate groups and the test results were in close agreement with carefully the same results. Boeing, Douglas and the National Aeronautics and Space Administration were each given a high time slot by the Air Force. Each of these aircraft had the wing attachment, wing root attachment incorporated. The test was then begun to determine exactly how long the modified aircraft would hold together.

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YZ-8P Now Powered by Artouste IIB

Florida YZ-8P vertical takeoff and landing aircraft is checked out after installation of a single Thiessen Artouste IIB gas turbine rated at 401 shp. The YZ-8P formerly was powered by two Lycoming O-435 rated at 180 hp each. The VTOL jet is offered an altitude of about 25 ft. (NAV Air 30 p. 7)

Utility Jet Testing

USAF this week began evaluation flight testing of both the Lockheed Jet Star CL-379 and the McDonnell TTP utility jet transports at Edwards AFB, Calif. Air Force decision on orders is expected by July 1.

First production non-converted Jet Star will go to Point of Whitney AFB in September 1960. Point of Whitney will receive its own TTP advanced engine and will utilize the 600-hp jet plane as a model. Following test work the aircraft will return to Lockheed's Marietta, Ga. plant for conversion to a Point of Whitney corporate airplane.

First delivery of a four-engine converted Jet Star will be to Comstock Co. in January 1961. Later orders for the CL-379 are placed last week by James A. Riden, president of Riden Service, Inc. of Miami Fla. The Department of Transport of Canada may purchase up to 10 of the Lockheed jet.

USAF Awards Douglas ALBM Design Contract

Washington-Air Force last week awarded Douglas Aircraft Co. a design study contract as a first step in the development of an intermediate-range, air-launched ballistic missile system. The contract is part of the competition by Douglas and General Electric's Light Military Electronics Department, Utica, N.Y.

Under the contract, Douglas will develop specific performance and test data "open when further cost and of technology studies can be based." Air Force said the initial study would then require approximately six months.

Thus far, General Electric appears to be the only firm associated with Douglas on the project. No commitments have yet been made on the propulsion system or other subsystem work.

The Douglas approach incorporates use of nuclear thermal jets as the power source for the North American X-15 recently around orbit than a gas-turbine thrust chamber (see p. 15).

Convair Gets Contract For Vega Space Units

Washington-Contract for \$15.5 million for eight Vega space vehicles has been awarded last week to Convair Aerospace Division by the National Aeronautics and Space Administration. Flight tests are expected by late 1960.

About half of the initial order of eight vehicles, which are to be delivered

by the end of 1961, will be three-stage Vega. Both two- and three-stage versions will use the USAF Convair Atlas intercontinental ballistic missile as a booster. Cost of the Atlas is not included in the contract.

Contract will handle design, construction, tests and launchings. NASA's Jet Propulsion Laboratory will handle technical suggestions and planning of plane in periods.

First-stage version will use a 14,000 lb thrust improved version of General Electric's Vanguard engine with solid-pilot guidance in the second stage. It will put a two-ton capsule carrying test items into a 300-mi orbit. General Electric has been awarded \$4.12 million for development.

Three-stage version will add a 6,000 lb storable nitrogen retrograde and solid-rocket engine now being developed by Jet Propulsion Laboratory under a \$6.4-million contract. Third stage will carry solid guidance and control jets.

Missiles for the three-stage version will include sending a 1,000-lb payload to the vicinity of the moon, returning several hundred pounds to the earth and sending 750-lb payloads on planetary missions.

News Digest

Canada, Ltd., subsidiary of General Dynamics Corp., has begun shipping Bomarc missiles and systems on schedule to Boeing Aerospace Co. The missile company, Seattle, is sending a Boeing subsonic (AO-7) Feb. 25, p. 25) was shipped from Bomarc to Seattle and will be used in Bomarc directed to USAF for armament of bases within the United States. Canada was generally regarded as a test of Canadian production facilities.

British aviation experts have marked up a four-month period, round with also at least \$1.1 million, according to Society of British Aircraft.

Guidance Shift

Washington—Final announcement of use of an American basic area developed initial guidance system as the Air Force-Convair Atlas KCB-1 is expected within the next months.

System was originally developed for the Atlas Titan (see p. 15) and was intended to be used in development stage that provided the switch to Atlas. Massachusetts Institute of Technology developed a further refined initial system for Titan. Production contract for the system has been awarded to the MIT's Propulsion of General Motors.

structure. However, Edward Bowyer director, and that despite the slowing the British industry must expect a "substantial drop" in exports.

India is expected to order a "second order" number of the Indian Satellite (S-1) intercontinental transport, according to Sir Ron. DeBorja managing director. Annual sales up to 40 per cent, will cost about \$4.75 million each.

Sylvania Electronic Systems, Waltham, Mass., has won a \$4,340,000 Department of Defense contract for production of a new military communications system. Details not received.

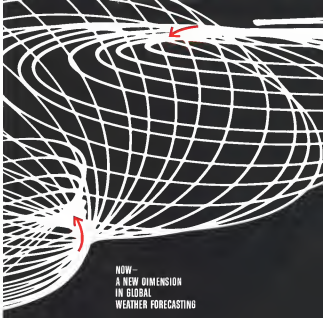
Advanced shipboard radar systems will be built for U. S. Navy by Westinghouse Electric Corp.'s Electronics Division under an \$8 million fixed-price contract. Contract includes production of long range air and surface radar search equipment.

U. S. Venus probes, once planned for early June, and a earlier launching of a 30,000-mi satellite are which equipment for the Venus probes was to have been tested have been postponed indefinitely because of engineering difficulties in both launchers and payloads. National Aeronautics and Space Administration and last week. Satellite that was Thor-Able III and Venus shot was Thor-Able IV and Atlas-Able IV. Six missions will be assigned to the vehicles.

Boeing B-52G jet bomber has made a record 10-hour flight of more than 9,000 mi without refueling the Air Force announced last week. Aircraft which made the flight on Dec. 15, as named in the air for 18 hr, flying a 160-km cruise course over the U. S.

Gen Lawrence S. Kuter, commander in chief of the Pacific Air Force, was named by President Eisenhower last week to succeed the retiring Gen. Earl E. Partridge as commander of the North American Air Defense Command. Appointment becomes effective on Feb. 11, date of Gen. Partridge's retirement.

Civil Aeronautics Board last week so affirmed its policy on "roll-back" crash fires and decreased complaints from four manufacturers—Delta Eastern, North coast and Northwest—against National Airlines' new route between Boston and Miami. Eastern and Northwest filed similar suits, complaining that the step was taken "retroactively" in respect with National Airlines Delta and Northwest plan to sue the law firm has been successful in the suit covered by the National law department.



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AIR TRANSPORT

Eastern Maps Plan to Regain Traffic Lead

Greater schedule reliability termed a key factor in bid to attract passengers, boost position.

By L. L. Doty

More Beach-Eastern Air Lines last week called for greater schedule reliability as a key factor in restoring the carrier's position as a leader in the number of passengers carried.

Eastern, which moved more passengers than any domestic or international airline in 1957, lost its enviable position last year, due principally to the effects of the 39-day labor strike late in the year.

The call for consistent on-time performance stemmed primarily from the carrier's president, Thomas A. Armstrong, at the spring national airlines and general board of directors meeting here.

The target is the government-owned airlines, which has lost standard Eastern procedure since 1947, not attended by close to 400 passengers and top-level management personnel. Capt. E. V. Rosenbloom, who normally quarantines the airline's operations in Houston during the first three days of the meeting attending Civil Aeronautics Board hearings on the Southern Transportation Route Case.

Slow Recovery

Armstrong told the group that recovery from the shock caused by the strike had been slow and stated that sales were not accelerated as Eastern is in long past competition in the jet market. In this connection, he added that "Eastern would be in a tough spot were it not for the Lockheed L-1049."

He said the Eastern fleet's progress to date, which saw sales of 15 jets on Eastern's order, had earned 148,750 passengers during the first quarter of the year and had gained 54.4 million in revenues. However, he pointed to the program expense and interest on loans as cost factors working from the company to produce equipment which will continue to grow and which cost he added by lower sales.

Expanding costs, resulting from introduction of jet equipment in establishing adequate airport facilities were stressed by Thomas Armstrong, and will be the president. He said largest aircraft will make Chicago's Midway Airport completely obsolete and that automation and maintenance expense of the larger 707s will result in an annual capital operating cost of \$55,000 for Eastern in 1962 as compared with its current Chicago capital cost of \$30,000 yearly.

Lockheed added that roughly 50 million will be spent by eastern airlines in moving the wing from Willow Run Airport to Metropolitan Airport in Detroit.

Increased Landing Fees
Landing fees will also climb, Lockheed said. For example, evening landing fees at New York's LaGuardia Airport of \$565,000 a year will reach \$425,000 in 1962. He said the airline's budget at Newark, N. J., is inadequate and must be replaced by a new \$4 million budget.

The other airlines factor he said the original estimated cost of the company's new budget at New York International Airport of \$12.7 million had already jumped to \$19 million.

Rising payroll costs in the company also were not forth during the meeting. The company is anticipating a 4% increase in payroll costs and a 5% increase in the next 12 months.

Wage level set in 1955 to \$105 million last year.

Higher payroll costs such as the increase plus usual increases and an employment of 100,000 will boost wage costs another 15% during the year.

Schedule Pattern

Armstrong said that the airline has established the best schedule pattern in the company's history. He pointed out, too, that the 115% increase in the number of available seats which became of better this spring will be cut quickly by management if load factors are not sustained at a high level.

On this point he told the group that Eastern, during the month of March, was still lagging in its drive to reach traffic goals last experienced by its own pattern. Eastern showed a 1.9 point gain in load factors during the month as compared with a 7.5 point gain for National, 4 for American and 3.7 for United.

United's reported decline of 7.5% points in load factors was attributed by Armstrong to competition from American's Boeing 707 jet transport flights. United's present schedule factors are about 115% passenger aircraft seats served to provide a total capacity of 13,500 seats daily. Each day the company will operate 511 flights representing 1,399 departures. Because the record between 4 and 5 a.m. is the most attractive departure time

Comet Sales Future Unpromising

London—Despite a concentrated sales effort, de Havilland Aircraft Co. Ltd. has not received enough orders to make the Comet 4 project remunerative. And in the U. S. it seems unlikely that new sales American companies can sell to airline operators there, according to de Havilland Chairman W. E. Moss.

De Havilland has sold 13 Comets to 10 airlines and is making additional sales in hopes of meeting six delivery dates specified by the new buyers, Moss stated.

No sales for the Comet have been forthcoming from the U. S., which, he said, represents more than 70% of the world market for airlines of that size.

"It appears unlikely," he said, "under present circumstances, that a new American company can achieve any substantial success in selling to operators in the U. S."

Nevertheless, there is "some" speculation among not only from the U. S. but France, and some from Rome, Moss said, and he said the government to talk to and providing a new policy for the airline industry.

Development, testing, and preparation of the Comet 4 for flight out of de Havilland was "a matter of pride" for the chairman said. And although the government made a contribution it amounted to "a small fraction of the cost."

Newcomers in the U. S., France and Rome, he said, are naturally excited by sales from their governments.

But despite disappointment in Comet 4 sales the company is going ahead with the design and construction of the Comet 121 jet for sale to British European Airways. This project is scheduled to enter service in 1963.

WIRE FOR ASTROMATIC, TELEPHONE 400-6000, 400-6001, 400-6002, 400-6003, 400-6004, 400-6005, 400-6006, 400-6007, 400-6008, 400-6009, 400-6010, 400-6011, 400-6012, 400-6013, 400-6014, 400-6015, 400-6016, 400-6017, 400-6018, 400-6019, 400-6020, 400-6021, 400-6022, 400-6023, 400-6024, 400-6025, 400-6026, 400-6027, 400-6028, 400-6029, 400-6030, 400-6031, 400-6032, 400-6033, 400-6034, 400-6035, 400-6036, 400-6037, 400-6038, 400-6039, 400-6040, 400-6041, 400-6042, 400-6043, 400-6044, 400-6045, 400-6046, 400-6047, 400-6048, 400-6049, 400-6050, 400-6051, 400-6052, 400-6053, 400-6054, 400-6055, 400-6056, 400-6057, 400-6058, 400-6059, 400-6060, 400-6061, 400-6062, 400-6063, 400-6064, 400-6065, 400-6066, 400-6067, 400-6068, 400-6069, 400-6070, 400-6071, 400-6072, 400-6073, 400-6074, 400-6075, 400-6076, 400-6077, 400-6078, 400-6079, 400-6080, 400-6081, 400-6082, 400-6083, 400-6084, 400-6085, 400-6086, 400-6087, 400-6088, 400-6089, 400-6090, 400-6091, 400-6092, 400-6093, 400-6094, 400-6095, 400-6096, 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Carriers Study Plan to Boost Subsidies

By Robert H. Cook

Washington—Subsidy payments to local service carriers could be increased by as much as 20% upon adoption of one of nine additional versions of a Civil Aeronautics Board order regulating passenger loads under study by the carrier. Procedure now formulated by a private research firm employed by the agency and based upon a suggested CAB plan.

Although initial payments would be significantly higher than collected under the current subsidy formula, this Board's latest plan (AW No. 10 p. 46) and modifications recommended to the airlines by economists of United Research, Inc. are considered by knowledgeable spokesmen as the first practical methods evolved to meet the individual needs of the carriers and eventually free them from dependence on government financial support.

Rebate CAB Concepts

While the airlines have not yet publicly expressed a preference, each of the modifications is tailored to suit the basic concepts favored by the CAB. Both the Board and the airlines are in tentative agreement on the new, six-weekly, concept, and they should eliminate first-classing and last-classing and final and rate hearings, settle the controversial question of a proper rate of return, adjust better control of subsidy payments by the CAB through grants, and create standards for specific operations based on program made with a profit taking management, and give the airlines greater management freedom based on knowledge of predetermined subsidy payments.

Framework of the CAB proposal, upon which the modifications have been designed, is built around a dist-

ribution, under which each carrier's current route distance would be reduced monthly at a percentage rate determined by the frequency with which it operated routes and a formula setting forth assumed passenger loads which increase with frequency.

Any increase in service beyond the CAB established formula would decrease the amount of subsidy paid, with each route distance held as a constant. Insurance on subsidy carriers would be allowed a reasonable profit as part of subsidy payments and those making a 10% profit (after taxes) on any route would receive the full amount. Profits between 10 and 20% would be split evenly between the air line and the government.

While the United Research modifications follow the general pattern laid out by the Board, they are more conservative. To the Board's basic "rebate" subsidy, the company has recommended adding a "bonus" subsidy plan an alternative of 10% of operating route distance, which would be deducted from the main rate of distance and subsidy.

While modifications were submitted for carrier study, but the company also submitted the same plan similar to the CAB proposal is hoping to provide other advice to subsidies or incentive to further adequate air service to the public. The data and the five remaining Board alternatives provided private study, but failed to reflect the need of expedient airline service.

The Board plan calls for subsidy payments based on the first six daily round-trip flights on the line of a scheduled route of U.S. cities, nos. 11, 13 and 15 passengers per flight. United Airlines took this concept to be expanded to include subsidy on the six-week flight program on the line of lands of 15 passengers to provide good frequency. Upon

that base the CAB will design subsidy plan tables of 51,831 per station served per month and the deduction of 10% of operating revenue would be applied.

In addition the method includes the following provisions:

- "Experience adjustment" similar to CAB's profit during plan by which the future income of carriers with high profit is reduced. Large deviations from the Board's plan would be a quarterly-up or down in an amount in excess of cost and income standards.
- Adjusted route definition to provide a more realistic rate of subsidy for short flights and short route carriers.
- Taxation of flights performed with such not DC-1 equipment as the Macon, Convair and Fairchild T-27s into commercial DC-3 equivalent for operating cost figures.

Had this plan been implemented during 1978, in which the 11 local service carriers collected \$53.5 million, it would have boosted their subsidy payments to an estimated \$40.5 million. The United Airlines indicates average subsidy payments of \$2.5 million would be increased to approximately \$3 million per airline.

Frequency Rule

Basic step on CAB's suggested plan concerns the definition of routes so as to establish load upon a national frequency basis. The number of scheduled flights on a route is calculated by dividing all departing route distances. An alternative by private adequate frequency, while avoiding the possibility of inhibiting new route requests in the frequency category, is to base subsidy on the number of routes served by several segments, the number of flights scheduled be multiplied by the number of such segments. Segments with an immediate return to the origin are not counted with their terminal points in interchanges with other segments would not be counted.

The Board's proposal also contains a mileage rebate, based upon each carrier's total operations cost. The United Research plan would limit mileage subsidy only to those of such direct aircraft operating cost. Part of indirect cost of station operations would be subtracted directly on the basis of the number of airports operated by each carrier. Modified formula suggested by the researchers would pay subsidy at a standard rate of \$1,831 per station a month, plus a variable subsidy paid at an rates based upon direct operating cost plus 41 cents per DC-3 mile.

With the CAB's standard operating cost figured at \$1.89 per mile, United, based upon an average 88 on stage

length, the economists have expanded the CAB plan to include phase table costs of \$1.92 for Convair and Macon and \$1.71 for the Fairchild T-27 based upon a DC-1 equivalent factor to encourage airlines to use equipment which attracts the most passengers.

Actual subsidy paid would vary with the load scheduled of each trip. For example, under the Board's proposed plan, a flight departing with 100 passengers could net subsidy of \$1.89 (DC-1 equivalent) minus a \$22 cents (total passenger load) or \$1.67 (total passenger load). No T-27 flight under the new formula would lose subsidy, could net \$1.47 per month mile.

To compensate for wars, short-haul routes, the recommended proposal also suggests that mileage subsidy be deducted by an amount equal to the number of miles of the airline's routes based on the number of scheduled routes and distances, with the other half determined in the total scheduled mileage. This would be accomplished by a formula of a fixed amount of 40 mi. per route distance plus one half the actual route mileage at flight distance. An actual route of 50 mi. would then be adjusted to 70 mi. for subsidy purposes, then paying route subsidies with closely spaced stops with a greater subsidy per mile flown and a greater number of scheduled flights.

A standard rate of return of 10% on investment, after taxes but not less than 24 cents per aircraft mile, also has been built into the formula, with United Research pointing out that the percentage gain is equivalent to the rate of return on a 10% of stockholders' equity plus 10% of long-term debt.

Western Plans Lease Of Allison Turboprops

Washington—Western Air Lines and Civil Aeronautics Board approval of a lease of an aircraft leasing firm by the Alaska Division of General Motors Corp., a move first reported by Aviation Week on April 16 in 49.

Terms of the lease, expected to use the airline on scheduled routes, will be the usual sort of leasing a fleet of some Lockheed L-1049 turboprop transports, over the rental of 55 Allison T-56 engines associated at a fee of \$100 each from the Al West Leasing Corp., a wholly owned subsidiary of General Motors. Delivery of the first engine, costing \$85,000, was scheduled last week, according to Western.

Similar to Alaskan Airlines' long-term agreement with the Al West Leasing Co. also provides for an option to purchase the engines outright at a rate by payment of 10% of the engine cost or balance of the unamortized cost, which over a greater

FAA Studies Computer System To Forecast Air Traffic Growth

Washington—Instant prediction of one phase of air traffic for the next 20 years by the Federal Aviation Agency is expected to be available within the next six months.

Structures for Reno-Mesa and Honolulu, which began formulating a special FAA traffic forecasting project last July, reported last week that major segments of the study have been completed, including availability of a computer computer of 58,000 words, program and related flight route data, and the availability of the computer with 536 general and military aviation fields plus even more point-to-point scheduled airlines. The data obtained has been used to provide information on actual air traffic at each season period this year.

A second field survey to meet the demands of peak summer air traffic is planned for a four-week period. By the end of the survey, the estimated flight of 119,500 flights throughout the country in total, the two surveys will cover 82% of the nation's total flights, 52% of the 63,000 general aviation flights, and 80% of the nation's total flights, and 44 of the 58 cities, including data from Alaska and Hawaii, the first reported. Scope of the data being collected includes passenger volume, by IBM T-99 computer is designed to provide information on a broad range of subjects such as:

- Variations due to aircraft and pilot characteristics.
- Variations due to different weather conditions.
- Variations due to time of day and time of week.
- Regression season time (season) effects.
- Regression effects upon flight activity, altitudes and aircraft type.
- Effect of economic conditions on carrier schedules of the number of air traffic flow.

Realization of completion of the summer survey, along with its intensive weather study being conducted in conjunction with several hundred weather stations and covering 320 weather areas, will form the basis for determination of a correct formula to predict air traffic flow in relation up to 1996. Final selection of the proper formula should be available in June.

The creation of new carrier studies in the future to create the planned accuracy of the method this year.

End results of the current project will be the development of approximately 118 mathematical equations, each

of which will be capable of forecasting specific phase of air traffic activity in the present and over the next 10 years. Direct output are expected to cover more than 25,000 specific air traffic information which FAA will use in future traffic control planning.

Philosophy behind the study seeks to establish a general mathematical formula for future prediction of air traffic, along with short modifications, in terms of studying current air activity and forecasting information on the impact with data compiled in 1979 seasonal and economic forecast. Application of the mathematical techniques of mathematical regression analysis is expected to establish a knowledge between the environmental factors, such as population and location of airports, population and economic growth and the observed flight activity. The study will also include a detailed forecast of annual arrivals and gate turnovers which will eventually cover more than 100,000 pilots. Military service is being conducted by the Air Force, Navy and Army, and the private and military effort is being handled by the Civil Air Patrol. Independent checks of the survey validity have been built into the program.

Data assembled in the electronic computer will be used to establish forecast major tasks performed by the IBM T-99.

- Summation of an expected total of 100,000 flights with an estimated classification of 100,000 flights.
- Additional information needed to further analyses, such as purpose of flight, IFR/VFR, flight patterns and altitudes.
- Regression of sample flight activity information to estimate of the total carrier taking place over the U.S.

Time savings time available to FAA in determining future traffic, placing of facilities and improved flight times for passengers and mailmen are expected to be a major advantage over the computer can generate an estimated 16,000 flights per hour, according to agency spokesmen.

Detailed breakdown of information scheduled to be readily available on IBM cards splits aircraft and carrier area as, separate categories, covering local and even country flights including such as 100 airports plus information on international terminals and flight traffic density figures for local flights over 67 per hour and 920 spots per hour country flights, traffic flow between 225 spots an hour and a detailed study of landings and takeoffs.

Subsidy Payment Squeeze

Washington—Civil Aeronautics Board is being forced to face subsidy payments to local service carriers because of a congressional desire to improve a supplemental appropriations bill. Conflicts have placed stress on the carrier in actual financial position.

A spokesman for the local service industry said the CAB would the local service as much as it could per only 40 cents on every dollar of subsidy reported paying approval of the supplemental appropriations bill. He added that, unless action is taken in the next future, the carrier will not be able to meet first priority bills they must begin to pay on a basis toward their own subsidy payments, and have little or no cash income.

Funds reported by the CAB for subsidy payments amounted to \$15 million and were considered in the second supplemental appropriations bill for Fiscal 1979. The House approved only \$12 million for this project, but the Senate increased it to \$36.4 million and added Senate members to work out legislation with the House. As of late last week, however, the House had not acted on the measure.

USAF Studies Off-the-Shelf Cargo Jets

By Russell Hovell

U S Air Force, citing two and a half billion dollars in off-the-shelf cargo transport will make up the bulk of the cost of a cargo jet with such and other features as planned, according to Carl Carl C. Hovell, of the Directorate of Transport, USAF Headquarters.

USAF is reported working closely with Pan American World Airways on this task.

Hovell emphasized that USAF will want on straight in loading. Loading loading cargo configuration proposed in a recent of lowering the floor has been turned down because of complexity and weight.

U S manufacturers currently are going wrong way too common of cargo jets to compare with the straight in loading demand. USAF has stipulated that the cargo jet must offer a 90,000 lb payload at 1,500 feet with a 100 mph load factor of 1.5 and a 100 mph of payload for fuel to extend range to 5,000 miles on a 20,000 to 30,000 lb. tank (AW Feb. 23, 1977).

The off-the-shelf guidance is necessary, Hovell said, because the aircraft is needed for the period from 1981 to 1978 and at present there is another new way, to obtain a plane easily tailored to USAF needs.

Jet Integration

Hovell said the requirement for cargo jets goes out of a need to integrate the transport function with other functions. It is not then possible to share either solid rocket boosters or the fuel tank with Air Force Hercules and it will thus be possible to deploy strategic nuclear weapons and other weapons over such north and recover strategic bombers without delay when they land at advanced bases after completing a mission. Delay in getting a recovery team and base parts and to the remaining air plane loss or in an exposed and vulnerable position. It would also be used for emergency, emergency evacuation.

USAF also is looking for a large range low speed transport and medium speed. Officers concede that the demand for that must be balanced against the need for a worldwide heavy cargo carrier. Hovell said that proposals on a new aircraft for the Douglas C-124 are being studied. Meanwhile, the first generation of cargo jets will stem from a contract that is not yet in final flight a war on cargo, even though it can be reasonably predicted. Regarding security, cost production, and trials in overall life, however, because the Air Force cannot afford complete specialized fleets, Hovell said.

Rapid progress in the field of personnel and accommodations complicates the question of when it becomes economical to re-equip a transport fleet. USAF apparently has decided that a cargo carrier program of the present time, can increase the services capital in while cutting transport and operational requirements.

Loading Study

At the invitation of Boeing Airplane Co. USAF has a loading study on the Boeing 707 freighter model at the Renton, Wash., plant. Final conclusions of the study which were embodied in the general operating requirements, called for:

- Straight-in cabin entry for straight-in loading of bulk cargo
- Cargo floor to hold at least 200 psf distributed load
- Ability to withstand wind and side loads of an Air Force 6, 6 truck, or a Boeing aircraft on the ground on its transport
- Cargo tie-down and handling system
- Accommodations for at least 110 troops and their equipment
- Provision to handle a load of an aircraft payload of 95 tons on the ground
- Another loading provision
- Fully compartment base to speed loading of sensitive equipment and protect it.

USAF says the cargo jet will have a payload of 11,000 tons. This is a 100 mph, 100 mph, level it is desirable for the in-cargo-carrying function. High speed aircraft carrier force can be made.

That of industries, however, according to U S, and Japan, level it is desirable for the in-cargo-carrying function. High speed aircraft carrier force can be made. That of industries, however, according to U S, and Japan, level it is desirable for the in-cargo-carrying function. High speed aircraft carrier force can be made.

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he headed by Brig. Gen. R. L. Wren, USAF, Director of Transportation.

Indicators was tested by test in a design competition involving a two-month study contract on Jan. 1, 1976. The study was the first of its kind, though it is being considered the fact that USAF estimates the study will require a 10 man year effort.

The response, in GOR 117, is known as Project 4631 in Air Research and Development Command. Final product of 4631 is called a "Military Loading Support System." Douglas Aircraft Co. and its design organization and sub-contractors during the study phase will include, Arthur D. Little Co. and Lockheed Business Machines Corp.

- Subject to the study will include:
- Aircraft cargo loading
- Cargo handling from terminal to air
- Cargo handling in terminal
- Air freight terminal design
- Data processing, communication and control of an airport
- Determination of various functions
- Marking and labeling of air cargo
- Packaging of air cargo
- Determination of optimum size for which to handle such cargo
- Cargo traffic analysis
- System simulation

Systems Analysis

Douglas will make operational systems analysis of all these factors. After completion of the study phase in June or February, 1980, a contract will not be made as the recommended design will be a minimum amount of prototype equipment and on a carefully selected cargo support. The actual system test would be preceded by using simulation of the system operating against a test.

So far, not will be followed by the next generation of the load system. Douglas end-product will include government data in the form of performance reports. Government will be a 100 mph, 100 mph, level it is desirable for the in-cargo-carrying function. High speed aircraft carrier force can be made.

USAF also is looking for a large range low speed transport and medium speed. Officers concede that the demand for that must be balanced against the need for a worldwide heavy cargo carrier. Hovell said that proposals on a new aircraft for the Douglas C-124 are being studied. Meanwhile, the first generation of cargo jets will stem from a contract that is not yet in final flight a war on cargo, even though it can be reasonably predicted. Regarding security, cost production, and trials in overall life, however, because the Air Force cannot afford complete specialized fleets, Hovell said.



Sud Aviation Unveils Triple-Turbine Helicopter

Sud Aviation's triple-turbine Model 3200 helicopter was a "striking good" test. Prototype is powered by three Turbomeca Vario 3 turbine engines, rated at 765 shp each. Main body Model 3200 is 11 m. in diameter, tail rotor diameter is 6 ft. 2 in. Helicopter will carry more than 20 passengers (AW Dec. 28, p. 25). Testing of second prototype will start soon.

U.S. Carriers Ask Caravelle Price

New York-Said, American received data to all the two jet Caravelle transport to the U S has resulted in requests from three carriers for firm price quotations.

The French manufacturer's opinion about U S sales possibilities are reflected by President and General De Gaulle, Georges Hovell, who said last week that the Caravelle is not to be operated by U S airlines before the end of next year.

The Caravelle is now "fully available," Hovell said, and production will start at least four airplanes a month by mid-1980. Breakdown production total is 170 aircraft, according to Hovell, and markets outside the U S should account for at least that figure. He said the potential Caravelle market at 30 in France, 30 in South America and 40 in other parts of the world but not including North America. Since the U S market would then be all profit, Sud said he is prepared to establish an elaborate sales office in the U S to help sales here.

President, last factor of the Caravelle is a typical U S market over a stage length of 100 feet, he would be about 175 ft. according to Hovell. Seat mile rate would be 0.5 cents per mile. At full gross weight, the Caravelle, with a wing loading of 60 lb. per sq.

United to Supply Crews To Japan Air Lines

Chicago-United Air Lines has agreed to handle Japan Air Lines with flight crews for transpacific flights between the U S and Tokyo.

Personnel involved in the agreement will include captains, pilots and flight attendants and may also be more in 30 person.

United crew, which will be based at Los Angeles, San Francisco and Seattle, will supplement Japan's personnel complement now being expanded to cover new routes between Los Angeles and Tokyo that began Nov. 1 and between Tokyo and Seattle on the Great Circle Route which is expected to start June 27.

It was said to be capable of operating at about 200 U S airports.

Hovell said the U S public's reaction to get transportation indicates passenger isn't going to accept flying behind passenger's neck, wings, and jets will have to go to stage length of 700 to 1,000 in. He said the Caravelle has no competitors in its class and it won't have its second year, whereas the case of the Boeing 707, "it becomes well last only a few months" until competitive equipment goes into service.

Sud is indicating its U S sales pitch must strongly be presented among the services will not consent for short or medium range turbine equipment. United Air Lines President W. A. Patterson recently told stockholders he is not considering short and medium range jets such as the Boeing 737 and Douglas DC9.

Hovell said the French Air Force is "not yet" interested in the Caravelle, although various versions of a Caravelle transport for the military are under study.



Directs You to Your Course . . . and Keeps You on it

ARC'S CD-1 COURSE DIRECTOR, TEAMED WITH TYPE 15 OMNI RECEIVERS

To be sure of the exact headings required to intercept and fly any desired VOR radial or runway localizer, pilots no longer need perform complex mental calculations. ARC's Course Director (CD-1), teamed with single or dual omni-range receivers, relieves the pilot of many problems — does most of his work . . . tells him when he is flying right. No more worries over breaking or missed approaches.

Simply select the desired VOR or localizer station, set the course director to the bearing of the selected track and turn the aircraft until the vertical needle of the cross-pointer is centered — then steer to keep the needle centered. The aircraft will intercept the right track and follow it. Wind drift is no problem, as the instrument compensates for this automatically.

Here is precision flying — simplified navigation, engineered and built to perform dependably. Ask your dealer to install the ARC CD-1, along with a dual installation of ARC's Type 15-E VOR equipment. They work as a team for safer flying.



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VOR AND VOR RECEIVERS AND TRANSMITTERS • VOR RECEIVERS • COURSE DIRECTORS • AIRCRAFT OMNI RANGE RECEIVERS • COURSE DIRECTORS
IN CHARTERED AIRCRAFT • COURSE DIRECTORS • COURSE DIRECTORS • COURSE DIRECTORS • COURSE DIRECTORS • COURSE DIRECTORS • COURSE DIRECTORS

SHORTLINES

► **Allegheny Airlines** reports that it lost 41,400 passengers, 7,501,000 revenue passenger miles during April for an 11% gain over the same month of 1955 and a new company record. Combined air express and air freight shipments posted a 21% gain over April of last year at \$87,466 lb., with freight figures alone up 64%.

► **British Overseas Airways Corp.** will accelerate its Harlingen-Corral flight on its London-Hong Kong-London route from four to eight flights each week beginning Aug. 1. Workload figures are expected to take 22 hr., 50 min. Certain scheduling of the week-end route will permit departures at 08:00 a.m. from Hong Kong, arriving London at 9:50 p.m. the same day. All times are local.

► **Continental Airlines** plans to spend an additional \$650,000 to expand its Los Angeles maintenance base in preparation for Boeing 707 jet transport flight beginning June 1. The addition will use Continental's aircraft at Los Angeles to \$1.9 million.

► **Korean Air Lines** has signed a \$1 million contract with The Gibson Refrigerator Co. of Greenville, Mich., for transport flights from 74 points in the U. S. to Seoul, Korea. Operations include an anticipated 1,000 Gibson dehydrators, and their use to be down on all monthly flights.

► **Schena Belgian World Airlines** has installed a 1,600 m. high-speed communications system connecting 19 of its 27 offices in the U. S. with New York, cutting time in cable and coast-to-coast transmissions. All of Schena's flights across the Atlantic and through the carrier's entire network. Not work was installed by the Long Lines Department of American Telephone and Telegraph Corp.

► **United Air Lines' board** of directors has declared a quarterly dividend of 12 1/2 cents per share of common stock, payable in June 15 to stockholders of record as of May 15, plus a 3% stock dividend payable at the same date.

► **William C. Weld Associates** has sold two Douglas DC-4 aircraft. One to Ocean National Airways of Baltimore has been delivered; the other goes to Tenthredin Central Aircraft Co. of Los Angeles. Latter aircraft is now being re-evaluated at the company's shops in preparation for delivery. Prices involved in sales were not disclosed.

AIRLINE OBSERVER

► Reported once by the White House to push a national defense name to 53 the next Civil Aeronautics Board voters could create strong isolationist reactions. Passages of the day approach, stress from a desire to add to the prestige of the CAB, but most industry leaders would prefer to see ability to select a new Board member. Herman D. Dorn's name appears in the list of all the civil and Commercial Justice District, whose name appears in December, 1955, is still expected to be named to the judgeship of the Federal Court of Claims in first reported by American Week (AW Mar. 16, p. 17). Recommendations of Edward G. Gossard, Federal Aviation Agency Administrator, will play a major part in President Eisenhower's final choice of the two appointees.

► Serious consideration of a Mach 2 "jetliner" transport for operation at 20,000 to 24,000 ft. has been added by R. D. Johnson, an assistant chief engineer of Bristol Siddeley Engines, Ltd. Dr. Johnson, head of the British company's transport department, admits a design study of such a transport would be "speculative" but believes the plane would have enough capabilities to justify the study (AW Mar. 6, p. 75). Idea calls for a 200,000 lb. bomber aircraft with short runway capability, which would take the transport transport to Mach 4 at 90,000 ft. Launch plane would then return to its airport, while the 130-passenger transport would accelerate to Mach 7, flying London to Vancouver in 75 min.

► Group in USAF's Air Research and Development Command is on quick release of a USAF requirement for a jet-powered transport. North American Airlines with the B-78 Mach 1 bomber and General Electric with the J45 powerplant for the B-70 are regarded by other manufacturers as in a strong position in such a case, and an effort is being made by them to create competitive designs.

► **Aeroflot** claims that its passenger traffic broke all records during the first quarter of 1956, rising 100% above the same period of last year.

► **Russia** has inaugurated its second scheduled helicopter passenger service with 18-passenger Mi-6's. New routes are along the Caspian coast of the Black Sea from Adler northwest to Sochi and Taganrog and southwest to Cagay. Also Aeroflot's Caspian helicopter service began last year between Simferopol and Yalta. The Mi-6's are primarily for sightseeing. This summer, the Mi-6's will make sightseeing flights to Caucasus mountain villages.

► **Aeroflot**, the Soviet-owned airline, plans to make its monthly-inaugurated B-18 helicopter passenger service to "a series of additional flights" by summer. New routes will include Moscow-Moscow-Vladivostok (Soviet Union), Moscow-Simferopol (Kremlin) and Moscow-Vladivostok (Central Asia). First scheduled B-18 passenger flights from Moscow to Adler and Almaty begin April 24.

► **International Civil Aviation Organization** is warning that increased speed driven over their new planned in the waters of the world for air traffic control and navigation facilities will be essential for the safe and economical conduct of commercial helicopter flights.

► **Continental Airlines** expects that 80% of its jet units will be operated by Boeing 707 turbojets and Vietnam Viscount turboprops by this October.

► **Dallas Air Lines** will inaugurate a 2 hr., 15 min. nonstop Detroit-Miami schedule in October with the first of its fleet of Douglas DC-4 turboprop transports. The airline will operate 14 round trips weekly.

► **Pan American World Airways** will make its peak summer firm and Rose jet schedule, which will begin June 1, through August. Stop not only will provide Boston with transatlantic jet service but also should ease Pan American's last-summer runway and noise problems at New York International Airport.



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ONTARIO

Airline Income and Expenses—February, 1959

THE BOLLARD

	Passenger Revenue	U S Mail	Express	Freight	Charter	Total Operating Revenues	Total Operating Expenses	Net Income Before Taxes
BOEING 747S								
American	31,129,230	266,468	7,933,393			39,329,091	36,991,863	-2,402,480
Boeing	47,128,492	138,348	81,187	149,293	2,943	47,499,863	46,999,995	499,868
Boeing II	7,326,430	186,712	81,876	87,858	9,337	7,703,183	6,637,312	1,065,871
Continental	7,452,620	56,122	13,644	44,893	3,600	7,580,289	6,891,703	-688,586
Delta	7,094,000	149,208	74,380	261,200		7,484,188	7,238,000	246,188
Eastern	19,472,235	225,719	744,434		42,463	20,442,851	19,383,828	1,059,023
Northwest	6,158,750	10,500	31,380	34,283	7,561	6,233,974	5,938,066	295,908
United	17,879,331	58,886	13,463	33,346		17,951,026	17,595,094	355,932
Western	4,453,238	173,316	647,193		163	5,273,807	4,985,283	288,524
World	14,485,880	307,184	334,700*		49,739	15,137,703	14,579,484	-558,219
United States	10,418,419	659,796	1,021,340*		87,430	12,187,385	11,795,196	392,189
Western	3,227,308	37,413	34,360	61,847	36,541	3,367,468	3,287,082	80,386
INTERNATIONAL								
American	41,142	2,700				76,189	414,213	-83,897
Boeing	499,454	8,242		43,219		557,915	634,595	-10,476
Boeing II	395,240	2,349		9,788	1,207	408,584	371,319	37,265
Continental	756,000	4,000		33,960		800,000	813,000	-13,000
Delta	1,658,219	16,218	71,960			1,746,397	1,497,885	248,512
Eastern	152,658		433	1,814		165,205	147,000	18,205
Northwest	339,432	3,419		9,213		352,064	266,884	85,180
United	1,077,489	406,292	270,418*			1,754,199	1,515,744	238,455
Western								
Asia	129,000	10,000	31,000*			170,000	373,833	-194,833
Africa	6,144,000	614,000	834,000*			7,592,000	6,747,000	-1,744,000
Latin America	3,698,000	147,000	7,363,000*			11,208,000	9,368,000	-1,840,000
Europe	2,792,000	144,000	277,000*			3,213,000	2,644,000	-569,000
Pacific	1,144,000	47,000		123,000		1,314,000	1,334,000	-20,000
Rest of World	2,007,333	420,333	869,166*			3,296,833	2,857,833	-439,000
United States	6,827			18,463		24,690	11,000	13,690
Western	174,122	6,487		5,874		186,483	186,122	361
LOCAL SERVICE								
Boeing	388,748	13,126	8,544	10,474	484	408,386	766,888	-378,502
Boeing II	268,480	9,737	1,763	3,720	773	284,683	389,475	-104,792
Continental	156,106	5,345	1,421	8,148		171,020	166,548	4,472
Delta	140,374	3,669	9,070*			153,113	203,437	-50,324
Eastern	813,485	4,913		7,478		825,876	793,362	-32,514
Northwest	555,810	21,020	12,090*	81,911		670,831	1,041,340	-370,509
United	945,447	917,469*	2,711	11,622	17,837	1,883,286	1,747,000	-136,286
Western								
Alaska	438,371	8,445	4,366	4,813	5,748	457,343	599,640	-142,297
Seattle	959,199	7,654	3,323	3,421		973,597	1,031,128	-57,531



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4 PRINCIPAL REASONS

why the Canadair-Convair '540' jet-prop is the most attractive executive aircraft and the new challenger for corporate flying

1 Because it adds jet-prop power to what is already the world's NO. 1 corporate airplane

The Convairs are the most popular choice of businessmen throughout the world for large executive or corporate aircraft and have long measured up to the exacting standards set for them in this type of flying. The Canadair-Convair '540' is powered by Napier engines and is the latest model, and the jet-prop successor to this very popular series of aircraft and provides even higher standards of all-around performance.

2 Because its roomier cabin space makes it functional for every business purpose

The roomy cabin interior of the Canadair-Convair '540' provides spacious work-in-flight area for as many as 14 people without any sense of crowding, or all the room you could desire for custom designed interiors of your choice.



3 Because the '540' has all the 'get-up-and-go' of the jet-prop airliner

You and your pilots will appreciate the airliner performance characteristics of the '540': take-off from most airports... rate of climb is 20,000 feet in 15 minutes... speeds up to 340 miles per hour... altitudes are anywhere above the weather up to 30,000 feet in fully pressurized comfort... and range is up to 1800 miles, such as Chicago to 'Primo', New York to Houston, or Seattle to St. Louis, without refueling. With extra fuel tanks the range can be extended to 2500 miles at long cruise power.

4 Because the '540' has operating characteristics that really make sense to the businessman

Let our Company representative call on you to demonstrate these and other important aspects of the Canadair-Convair jet-prop '540' in the executive version, or if you prefer, have us send you supporting literature.

You are invited to fly the '540' in a demonstration flight

Businessmen interested in large executive aircraft and airline operators are invited to fly the '540' in a demonstration flight. To schedule yours,

write or call Canadair Limited, Montreal, Canada, or Canadair Services Limited, 145 Park Ave., New York City.

Most important to you:

The '540' is a product of Canadair which, as a member of the General Dynamics family of companies, is associated with the following corporate divisions that constitute this important enterprise and represent it in its many exciting fields of activity: Convair, for the Atlas missile

and missile programs; Electric Boat, for starship-powered submarines; Strengthen-Carlson, for nuclear instrumentation; General Atomic, for Triga research reactors; Liquid Carbonic, for production of industrial and medical gases; and Electro-Dynamics, for the production of electro-mechanical control equipment.

CANADAIR CONVAIR 540

JET-PROP EXECUTIVE VERSION

CANADAIR, Montreal, Canada
The Canadian Subsidiary of General Dynamics Corporation

CD-540-100

Long Kong airline has ordered two Lockheed Electra turboprop transports, the first of which is shown in operation for flights weekly between Hong Kong, Bangkok and Singapore with Douglas DC4s and DC-6s.

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Three
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Your letter dated 10/1/94 is received. Please advise me if you have any questions.

Bring a new world into ELECTRONICS

Designed for switching and amplifying applications at low and medium current levels, these Hughes transistors offer you a number of advantages:

- useful beta at extremely low collector currents

- $IV_{1,20}$ and $IV_{2,20}$ are smaller
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These EELA registered devices, now available in production quantities, are housed in TO-8 (single ended) and canner packages (dual in line). Registered for extreme reliability, several types meet MIL-T 10500A specifications.

Journal Portfolio Type	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
T2 & Specialty T2/T2-SE Portfolio Type	281,224	279,279	281,510	276,251	281,282	286,249	282,288
Go System to Journalize Indirect Bill and Charge (JIBL)	129	220	129	129	159	600	1199
Go System to Journalize Indirect Bill and Charge (JIBL)	159	600	129	129	129	600	1199
Journalize to Bank Portfolio (JBL) Type = JBLA	199	159	159	129	159	600	1199

[illegible]

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HUGHES PRODUCTS

How Soviets May Land Man on Moon

Dr. Howard Green, Editor¹

Shortly after the Russians launched their cosmic rocket on Jan. 2, they announced their intention to put a man on the moon and bring him safely back this year. How can they accomplish this, and what are the chances of success?

It appears that most of the major biological obstacles necessary for a manned lunar expedition have already been made. The Jet 2 sounding demonstrated the necessary advancement in propulsion. Flaming the dog Lark in orbit in 1957 indicated a reasonable knowledge of the behavior required to sustain life in space. The selection of personnel to make the trip should present no problem; there would undoubtedly be more volunteers than could possibly be used. If we can believe the reports, the training program is already well under way.

The second source assumes, perhaps to interfere, the moon is approaching more diffusely to earth. Unavoidably, some orbital correction will be necessary to arrive at the correct velocity for interception. A velocity of some 40 feet per second, or about one-tenth of the per cent variation in the orbital velocity, is the maximum allowable for a least landing. This would be well within reach of presently available guidance equipment if it were not for the requirement of landing near a target. The latter is a very difficult problem, since the moon's surface is within short distances of some projected locations but not moon's surface (JAW May 4, p. 31).

The use of manual lapshov paddles will be inadequate for such maneuvers. It will be necessary to carry aboard the vehicle either another control rod(s) or a means of firing the ramjet landing rocket motor(s) externally, in order to adjust both the course and the velocity when well inside the lower gravitational field. In addition it will be necessary to carry some sort of laser surface scanning equipment at least in the unarmored vehicle, to provide a reference for computing the position and direction of the trajectory adjustment. Both the laser, thrust vector and surface scanner are well within the present state of the art.

Let us now speculate on a possible

ment of completing a manual labor expedition. In order to send them on their way to the moon and get them back again with any sort of scientific data worth mentioning, the weight of equipment and atomic fuel would be considerable above that of the largest payload the Russians have thus far demonstrated. We can then assume that either a much larger launch vehicle than the first 2 cosmic rocket is being developed at the present moment, or that the first 2 launches will be restricted to the discovery of simple elements such as the "cosmic" clouds, described previously, for lunar use, but already being built and tested.

Theoretical Missions

If multiple line items are measured, the expenditure then might appear somewhat as follows:

for sea and inner surface exploration, and would be sent up. This would also down in order to the largest presently available rocket. It would also, as usual guidance equipment, telescopes, and other instruments, and would be provided with landing, recovery, control, and other instruments, a telescope, and a means of communication to the inner surface. The Russians have even said that a short mission like depicting an artist's conception of the planet's configuration and appearance. The telescopes would be used both for surface exploration and as a means of visual reference for terrestrial guidance. The propulsion

mental consent of a separate law-enforcement body, so health days for women and pregnant women would be the third type of installation. Another would be a drug-testing station to restrict narcotics distribution and limit, leaving enough to remove near the linear market, and also to allow use of a smaller, more mobile, controlled two for operating at optimum efficiency.

The surface locomotion system if we believe this problem, would consist of a surface of a single, raised, and a single type of track, installed in the form of the parkland. These legends show the structure would be positioned and the track lowered to the ground to the car moving on its own track. The main is watched on a TV screen back, on cars, and radio control units are used to either slow control and direction of the cars. The system is based on the scientific instruments shown by the bus to a information back to cars.

When the trailer runs out of fuel it stops moving, but enough electric power can be obtained from solar cells to operate the horizon and periodically, the solenoids, thus providing continuing information and a radio guidance aid for homing subsequent vehicles. Following is a tentative weight breakdown for a typical lunar lander vehicle.

* Vollerleber

Gross weight	3,245 lb
Diameter	65 in
Length	28 ft
Weight, retrograde prop lost	1,890 lb
Propellant, liquid oxygen	
Insulated	332 lbs
Turbopump and motor	
(Gross third stage)	440 lb
(Segment of first burnout)	
Electronics and computers	35 lb
Equipment and batteries	32 lb
Rocket motor and its equip- ment	40 lb
Structures and materials	35 lb
Total grossed weight	591 lb
Packed weight	794 lb

* Polycondensation

Feedlot capacity total	... 794 lb
Structure and loading gear	... 27 lb
Chickens and attendant	
control	... 120 lb
Housing equipment	... 25 lb
Miscellaneous equipment	... 30 lb
Total assumed weight	... 220 lb
Actual payload	... 592 lb

Refueling Vehicles Launched

Second, a series of three relaunch vehicles would be used up. Each is similar to the instrument carrier except that the payload consists of rocket-propellant instead of instruments and an exploding war! Television can now be replaced by satellite-borne equipment in the relaunch vehicles in order to conserve power and increase reli-

Each reflecting vehicle is self-labeled as near the instrument carrier as possible using the radio beacon on the instrument carrier as a hearing aid. The distance over which a fuel tank must be carried by a man must be kept as small as possible, probably, not over half a mile. All the reflecting units should be within the range of vision of the TV about the instrument carrier so that their headings and altitudes positions can be monitored. Since it may take some time to accomplish the

EQUIPMENT LIST AND WEIGHT BREAKDOWN

Manned Payload

[illegible]

Excellent Payload

Total payload weight available	592 lb
Tankage	72 lb
Valves and plumbing	5 lb
Provisions	526 lb

Instrument Payload

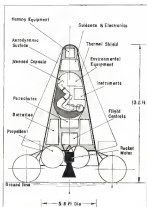
Initial available payload weight	592 lb
Mobile equipment carrier structure	70
Locomotion motor and controls	16
Locomotion fuel and oxidizer, and tankage	130
Propulsion and electrical system	150
Solar cells and battery charging unit	40
Thermal control system, total	36
Thermal control system	14
Recording and telemetry	21
Miscellaneous electronics and equipment	30
Scientific instruments, total	175

Lyons Voleballs, Complete

[illegible]

4104 • J. Neurosci., September 24, 2008 • 28(39):4100–4108

Field soil probe/valuable	175
Lower river trawl	20
Map stretching and contents	25
Reduction intensity meter	4
Microdialysis gas analyser	16
Ion gas	1
Soil submeter	2
Gravimetric field spectrometer	4
Cloud chamber and contents	94
Instrumentation and film and contents	12
Microchemicals and contents	9
Microchemicals datafile	8
Micro surface temperature sensor	2
Recording magnetometer	2
Shark water ecological propelling	2
Equipment	16
Microfossil instruments	7



MAINTAIN LUNAR VEHICLE proposal would be designed to send a man to the moon and bring him back after obtaining scientific data about the moon that would not be gotten without making the trip. Flight in both directions would be controlled automatically with the pilot acting as a monitor. On the return leg, midcourse and terminal thrust course laws would bring vehicle to atmosphere where hyperbolic flight phase of mission began. Capsule separates, parachutes to ground.

ESTIMATED PERFORMANCE FIGURES FOR A LINEAR CONDITION

[illegible]

²Everdoss Ebing is a bridge engineer in the Research Department, Development of Lockwood Greenleaf Corp's Member for more than 20 years. everdoss@lge.com



STEPS IN THE RACE TO OUTER SPACE

Nuclear Rocketship

Despite heavy high-temperature costs, lunar manufacturing should prove not unduly viable. With unlimited Scout power, controlled atmospheres and advanced automation, a considerable commercial could be realized as deficits in aluminum, rare minerals, reactor cores and other items that might be more efficiently processed or produced in the Moon's perfect vacuum.

To supply the Moon colonists and to carry their production back to Earth, special rocketships will be developed.

Nuclear energy is the most promising source of propellant power. The ship shown here utilizes nuclear fission for heat and hydrogen gas as a working fluid. From pressurized tanks, the gas is fed through a heat exchanger, expanded, and expelled for the motive thrust.

When the craft leaves Earth, it carries only enough gas for a one-way trip. After, by extracting hydrogen and oxygen from Lunar rocks, Moon settlers will be able to

refuel the rocketship for the return voyage. This will permit smaller fuel tanks on the craft and larger payloads.

Inertial navigation systems will play an increasing role in the exploration of outer space. *AMERICAN* is actively supporting the Air Force's program in long-range missiles and is in the vanguard of the race to outer space. *AMERICAN*, Golden City, N. E. A Division of American Bosch Arma Corp.

AMERICAN BOSCH ARMA CORPORATION

enter mission, variable thrust and no down signals at normal temperatures, rather than liquidated gases) are a necessity.

After enough velocity fuel is safely landed on the moon, the final, manned vehicle is launched. This vehicle is identical to the refueling units, except that the payload is a manned capsule, and the facing is of a thermal material for use as a reentry heat shield during re-entry into the earth's atmosphere on the return trip. The facing shape may be made so that the vehicle becomes a solar mission, suitable for use as an hegemonic glider. With this configuration the solar return mission velocity can be dropped at reentry, and it will act as a recovery to speed needed to arrive at close orbit before entering the re-entry trajectory.



Scout Configuration

Chrysler-Vought Aircraft Inc., model shows configuration of National Aeronautics and Space Administration's solid propellant rocket (AVR April 15, p. 27).

The only maneuver required will be that necessary to establish about the earth a highly eccentric orbit, with a perigee velocity just short of the disintegrative escape mission velocity. If the perigee of this orbit can be made to enter the reusable atmosphere, then acceleration down can be used to alter the trajectory in such a manner that the rate of horizontal burning of the vehicle equals the rate of heat radiation at a hypersonic wall below the trailing point of the rocket. This is achieved by low thrust rocket fuel from the method of establishing a close orbit as a basis for re-entry.

Loading of the manned vehicle is accomplished in the worst manner as for the previous unmanned vehicle. The landing spot should be partially in shadow for the duration of the mission to avoid extremes of temperature. Air ion loads, fluffy, correct, with dust should also be in mind. The flight is both directionally will be controlled automatically, with the pilot monitoring the operation. Until once it leaves about man's ability to function under long periods of zero gravity it would be unwise to entrust the mission to manual control except in emergency.

Moon's Surface

Once on the moon's surface, however, the pilot will be working in a positive field of about one-sixth earth gravity. With adequate precautions, it should be possible for him to spend short periods outside his capsule in a open spot collecting his fuel. Carrying the fuel tanks should be easy in reduced gravity. Every item of equipment, unless absolutely necessary for the return flight, should be left on the moon. Once the return vehicle is refueled and checked out, the remainder of the time may be spent taking photographs, making scientific observations, collecting samples of dust, lunar crust, and reporting findings to earth.

If it is important to maintain adequate mission radio communication between earth and moon at all times, distance should prove no barrier even for voice communication, if a radio signal can be reflected from Venus. The large tracking antennas on earth should make up for the shortage of power at the lunar transmitter. When the pilot has obtained his data he gets in the return vehicle and blasts off. Mid-course and terminal thrust corrections bring his vehicle to the edge of the earth's sensitive atmosphere where the hypersonic aerodynamic flight phase of the mission begins.

At a low altitude and a greatly reduced velocity the manned capsule is separated, and recovery is made by parachute.

Now that a possible manned lunar expedition has been outlined we can



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Republic Aviation Corporation has the complete systems responsibility for the Swallow development, working in close cooperation with U. S. Army Signal Corps Research and Development Laboratories at Fort Monmouth, N. J. and the Army Combat Surveillance Agency, Arlington, Va.

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is, the second question posed in the introduction, "What are the chances of success?" What would the reliability of such a mission be? As for getting information, the chances of success are fairly high during the normal part of the mission, since as more information is necessary, it may be located until one is well landed and performance is desired.

Low Reliability

As for getting a man safely on the moon and back, the reliability of any individual launching is probably low. The complexity of the vehicle, the time element and the number of launch attempts, under any one plan's chance of success is poor. This low reliability of any individual flight is a greater deterrent to a lunar launch expedition in the United States than is our technological lag.

In allowing volunteers to attempt such flights, Russia can not only get to the moon first, but can increase the reliability of the overall mission by increasing the number of flights of the manned vehicle in required for 100% success. By making down the payload weight we would be in as good a position as Russia at present to launch a manned lunar expedition. However, our philosophy of the privacy of the individual at the possible expense of the mission, makes it unlikely that we shall attempt such a venture for some time.

It may be asked what the overall purpose of the manned lunar mission really is. One obvious reason is the collection of scientific data about the moon that we cannot get by going there. Another is the propaganda value of demonstrating to the world the advanced state of a nation's technology. There are other scientific purposes such as proving the way for the establishment of a permanent station of lunar stations, an early terrestrial, low gravity launch point for space vehicles, etc.

Reason for Project

But, we may still ask, why must a human being be placed on the moon now? It is technically possible to put automatic controlled instrumentation in a manned vehicle to obtain any scientific lunar data which a man can get, and at less cost. However, placing a man on the moon is more than a propaganda stunt; it is an expression of the desire of a nation. The Russians have announced to the world that they will put a man on the moon and bring him safely back this year. This will be historic, unless they don't. They also talk to continue their operation for achieving scientific data. To improve the world, then, and above all, their own people, they have no choice but to make good.

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Military Application of Argus Doubted

By James A. Finck

Washington—Doubt has been raised as to the military usefulness of effects caused by high altitude nuclear blasts such as the Argus. Project Argus explosions over the South Atlantic Ocean last summer. Details of the Argus effects were presented to scientists but not such as the White House meeting of the National Academy of Sciences.

One of the potential uses claimed for Argus-type explosions is the total blackout of radio and radar at the geomagnetic conjugate point (AW April 6, p. 11) as a method of disrupting the mission capabilities of a nuclear-armed attack. Radio measurements made close to the conjugate points of the Argus blasts—near the Azores in lands-linked to detect no effect on frequencies in the range between 10 and 130 mc and only moderate reduction in signal level at very low frequencies.

Scientists proceeding the Project Argus data, however, estimated that the results of nuclear explosions at very high altitudes may be considerably different than the effects of the low yield Argus blasts. All three of the Argus explosions had yields of between 100,000 and 200,000 tons.

Possible Threat

One possible threat of nuclear explosions at the time, according to the man who proposed the Argus experiment, the self-taught Greek nuclear physicist Nicholas Christofilos, would be the creation of shells of intense radiation that would be a threat to space travelers. One negative result exploded in the proper location in outer space, by itself, would deliver to a man in a satellite a lethal dose of 400 roentgen in less than three hours.

Five symposiums, titled "Scientific Effects of Artificially Introduced Radioactivity at High Altitudes," featured papers by a panel of experts that included Christofilos, of the Lawrence Radiation Laboratories of the University of California, Dr. James Van Allen of the State University of Iowa and scientists from the Air Force Special Weapons Center, Kirtland AFB, Air Force Cambridge Research Center, and Stanford Research Institute.

The main purpose of the Argus experiments was to test the proposal made by Christofilos in an unpublished memorandum in October, 1957, that the electrons resulting from the radioactive decay of fission fragments and neutrons produced in the detonation of a nuclear bomb in the ionosphere upper atmosphere would be trapped

in the geomagnetic field and form a shell of radiation around the earth.

While the proposal was under study, the discoverer of the existence of natural belts of trapped radiation provided overall evidence in that it showed that charged particles could be trapped in the geomagnetic field. It became clear that the artificial injection of known charged particles along a known magnetic line of force at a known time would be a powerful technique for investigating more of the unknown aspects of the dynamics of geomagnetic trapping.

The project was carried out last summer under the direction of the Advanced Research Projects Agency. To determine the effects of the explosions, a group of about 500 scientists participated in taking measurements and observations at the firing location in the South Atlantic, at the conjugate point

near the Azores, and at stations of the International Geophysical Year throughout the world.

Argus Effects

Plumes and positively charged ions produced by the Argus explosions and trapped in the earth's magnetic field spiraled along the paths of the magnetic lines of force from the site of the blast in the South Atlantic into space a distance of about 4,000 km to the geomagnetic conjugate point in the northern hemisphere. These electrons not absorbed were reflected back and forth along the field lines forming a banana-shaped tube of radiation.

At the same time, these electrons tended to drift to the east because of centrifugal force as they bounced back and forth between the mirror points and because of the decrease in the magnetic field with altitude. This drift rate of the electrons is a function of

Data on Argus Explosions

	Argus I	Argus II	Argus III
Nominal Altitude	250 mi.	250 mi.	250 mi.
Nominal Yield	1 to 2 Kilotons	1 to 2 Kilotons	1 to 2 Kilotons
Approximate Time	0218 GMT	0320 GMT	2216 GMT
Of Burst	Aug. 27, 1958	Aug. 18, 1958	Sept. 6, 1958
Approximate Coordinates	W. Long. 8, 12 Deg. W.	W. Long. 8, 4 Deg. W.	W. Long. 5, 10 Deg. W.

Time to Drift Around the World

Versus Energy

Electronic Energy (Mev)	Average Time (minutes/revolution)
0.1	37
1.0	10
10	10
100	12.5
400	40
6.0	6.4
8.0	5.2

Summary of Observed Intersections by Explorer IV Giving Significant Data

Shot	Number in Northern Hemisphere	Number in Southern Hemisphere	Period of Observation
Argus I	21	9	Aug. 27–Sept. 6, 1958
Argus II	27	11	Aug. 18–Sept. 6, 1958
Argus III	61	27	Sept. 6–Sept. 19, 1958
Total	109	47	

CAPABILITIES FOR DEFENSE

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MISSILE GUIDANCE SYSTEMS Both ground guidance and tactical guidance systems are designed, developed and produced at Westinghouse. Basic electronic guidance systems are now being developed to replace those in production and in actual operation. The latest techniques in radar, infrared, and data processing and display are being applied in all phases of missile guidance by Westinghouse engineers with heavy participation in this field. *See Air and Ordnance Divisions*



ADVANCED ELECTRONIC SYSTEMS For weapons control, target identification, bombing and navigation, reconnaissance, surface, missile guidance, bomber defense and other applications are designed and manufactured by Westinghouse. Army B-26 Advanced Control System, shown above, for the B-26 Superfortress bomber, is a major example. *See Air Division*



PURIFICATION From the design of America's first jet engine in 1931 to 14 gas turbine engines at Westinghouse to present day engines for high speed aircraft, Westinghouse has kept pace with the aviation industry's constant demand for engines in engine power and efficiency. Current applications include the use of new engine and advanced design features to achieve maximum thrust in single cycle, high speed and high altitude performance. Jet propulsion engineering resulted in a new high speed jet engine designed by Westinghouse engine that design goals per 115 months after first flight were achieved. *See Turbine Division*



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HUMAN ENGINEERING testing and the results are used in the design of new equipment. Westinghouse has designed and developed new equipment for the defense, including the design of the control panel for the defense. *See Air Division*



UNDERWATER MISSILE LAUNCHER for the defense. Westinghouse has designed and developed new equipment for the defense, including the design of the control panel for the defense. *See Air Division*



AIRCRAFT ELECTRICAL SYSTEMS From Army to Air, Westinghouse has been producing aircraft electrical equipment for the defense since 1917. Westinghouse has been producing aircraft electrical equipment for the defense since 1917. Westinghouse has been producing aircraft electrical equipment for the defense since 1917. *See Aircraft Division*



NUCLEAR ENGINEERING experience is still necessary for the defense. Westinghouse has designed and developed new equipment for the defense, including the design of the control panel for the defense. *See Nuclear Division*



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Measuring Whole-Body Radiation Determines Effect on X-15 Pilots

Los Angeles—Effects of cosmic radiation on X-15 pilots can be determined by measuring whole-body radiation.

The investigative tool is measuring the radiation as a gamma counter which determines the amount of radioactive potassium in the skeletal muscle tissue. Preflight radioactive potassium amounts will be compared with the radioactive level of the potassium in a postflight examination.

Dr. Carl Bent Rosen, USAF (MCS), directed human factors support at the X-15 program at a meeting of the Aerospace Medical Assn., formerly the Army Medical Assn., during its 40th anniversary ceremonies, which were conducted during a business meeting at the Aero medical convention here. Increasing emphasis on the physiology of space travel prompted the same change.

Radiation Counter

A whole-body radiation counter is operated by the University of California at the Los Alamos Scientific Laboratory. The device, shielded by 30 tons of lead, uses a gamma counter and is similar in appearance to an iron lung. The examination takes about three hours. Half-life of radioactive potassium, however, is 12 hr. In an airplane, postflight radioactivity would return to normal in about three days.

Air Research and Development Command plans to obtain the use of a whole-body radiation counter for initial tests of its new Edwards AFB to determine induced radioactivity levels each following each X-15 flight.

Isolation and confinement studies involving subject groups of five men as well as single volunteers, indicate that psychological examination can offer clues to the kind of men who can accept themselves well in space missions. Stress and fatigue studies, conducted by Captains G. E. Ruff, E. Z. Leri and V. H. Thayer of the Bagdad House (Branch of Weight Air Development Center's Aero Medical Laboratory, showed that selection was more important in the single man studies than in a crew of five.

Five men crew studies, involving five days' confinement in a compartment measuring 17 x 7 x 6 ft revealed that the ordeal was no more than "moderately stressful." Thermal comfort in the preparation and eating of food was noted in each of the three groups participating in the tests. This was explained as an outlet for gregariousness which would normally have been satisfied by other means of expression.

Isolation studies, ranging in duration

from three hours to seven days, showed a wide variation in tolerance among the more than 100 individuals tested. In some experiments, subjects were kept in total darkness and silence. Others were subjected to continuous white noise and could see only a homogeneous field of light identified through hooded goggles. Physical activity was restricted to varying degrees in the experiments.

Capacity to withstand the experiments depends chiefly on the temperament of the individual's personality. Individuals with a minimum of emotional problems adapt most easily to the unstructured environment of isolation.

A total isolation flight program was completed to 45 hr. 5 min. at space equivalent altitudes (about 90,000 ft) in the Navy's Mark III Model II full pressure suit. Results of the postflight exposure indicated no harmful effects, according to a paper by Cmdr. Arthur L. Hall, MSC, USN, and Cmdr. Richard J. Merna, MC, USN.

Findings indicated men can tolerate total isolation at altitudes of 15,000 ft for 72 hr., that the Navy suit is tolerable at extremely high altitudes for extended time intervals and that man could function adequately with negligible physiological or psychological deterioration.

Oxygen Caused Dehydration

Dosages of oxygen produced some dehydration in the test program. Lt. Cmdr. Richard H. Toben, MC, USN, leading to an indication that most sensitive to oxygen would tolerate the problem.

At extreme altitudes (140,000 ft) subject could walk, move his hands, arms and head although his leg tremor movements were noticed under the rudimentary pressurization situation.

Oxygenation causes pressure differential what would be 14 psi, since breathing pure oxygen under this pressure obviously produced no harmful effects over long exposures, and this differential also required other structural requirements. Subject would be able to keep his faceplate open, since pure oxygen and pure oxygen combination produced the sustaining value of oxygen tension in the blood.

Both functions were presumed to become a problem after a four-day flight with the recommended procedure being to have two reserves should, so that one could either repair an inoperative pressure lock while the other was engaged in medical duties, or the being able to reward the person so engaged in case of a complete pressure loss, before a fatality occurred.

PUMP PRIMERS

by
Arthur A. Nichols

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Fig. 1. Pumping pump, designed and produced by Nichols.

Other materials now handled by Nichols pumps include: acetone in road oil treatment, lubricants for engine and gear boxes for ship, boat and airplane, fluids for hydraulic and aviation hydraulic servo systems and solvents for high-speed electronic equipment. (Pgs. 1, 2)



Fig. 2. Electronic equipment solvent pump.

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The Killer Camel (Continued from Double Back Cover)

begin firing in 1900 as he was within range—and the trencher Camel observed another victim. When this stubby fighter was first introduced in 1917, it took more lives of Royal Flying Corps pilots than the Germans did. As the war progressed, the Camel clocked up an astounding record of enemy kills: 1,614 confirmed victories, including 99 balloons and a Zeppelin.

Although the plane became the supreme Allied dogfighter of the war, only one Victoria Cross was won by a Camel pilot. The Camel was the favorite plane of many among British aces. One of them was Captain H. W. Wootley, D.S.O., M.C. On April 12, 1918, Captain Wootley shot down three enemy aircraft before lunch, then scored victories over a Fokker D III, a 2-seater reconnaissance plane, and a Fokker Triplane—a fast seldom-outgunned and never impeded.

The Camel demanded courage and intelligence of its pilots. For high maneuverability, its main wing was constructed in a short forward fuselage. Its biplane wings spanned only 28 feet, the upper wing was mounted high and the bottom wing had a high degree of flexibility.

The Sopwith Camel flew for 15 months with the Royal Flying Corps and the Royal Naval Air Service. The plane defined its name (at first mockingly) from the bumping of the panels which caused the destruction of the twin Vickers gun. The prototype had a 110-hp Clerget engine. Production models had a more powerful 130-hp Vickers, and some had a 110-hp Le Rhone. Although the plane has been described as "too slow to catch anything on its own day," it had more speed than the Fokker Triplane.

Its rotary engine had the effect of a 360 degree gyroscope. Pilots encountered their first problem with the Camel just after take-off: correct setting of the fine adjustment with the



CAPTAIN ROY BROWN
—the victim, Germany's greatest ace



throttle. If the mixture was not right, the engine would cut out at about 200 feet and the plane would head into a spin.

The Sopwith Camel saw extensive service against ground installations and troops. It was equipped to carry four 25-pound fragmentation bombs, and some reconnaissance pilots also added a basket of grenades to increase the plane's armament. Some pilots removed the landing strips from the lower wings between the wings to add a stream to the normal whine of the engine during stalling operation. The Camel was among the first planes used on Royal Navy carriers and also was used extensively in night flying operations.

The British built 5,492 Sopwith Camels. All war brochures to lull the and hell of maneuverability—but their unmatched maneuverability and light wing-dart turn contributed immensely to aerial supremacy.

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EXPERIMENTAL final assembly line for Bomarc interceptors as it looked prior to moving production to a new, state-of-the-art plant in Seattle.

Bomarc to Be Combat-Ready at Year End

By Russell Hawkes

Los Angeles—USAF's Boeing IM 99A Bomarc interceptors will be "on line" in September and a combat-ready weapon later in the fall. By late 1960, the successor IM 99B, with double range, better performance, much improved guidance and a much longer maintenance cycle, will begin to supersede it.

Canada will acquire two squadrons of Bomarc B at about the same time USAF begins getting it. Canadian

segments are helping to develop the new model on Boeing and subcontractor plants and are taking part in the test program which has just begun at Cape Canaveral Fla.

Area Defense

Unlike other surface-to-air missiles, Bomarc has no single launch-to-target guidance system and firing command is not externally issued at the launch site. It is remotely launched by a SAGE Direction Center and receives toward the target marsh data from a manned interceptor.

Self-contained nominal guidance target sector radar only controls the missile during the final run on the target.

Bomarc is an anti-defensive weapon similar to a manned fighter but since its mission is a one-way trip, none of its characteristics differ. Lack of a human pilot means somewhat less versatility in the combat zone, demanding a higher quality information about the enemy before launch and assembly results in loss of the interceptor regardless of whether its mission is accomplished. Boeing says the missile is necessary based upon the assumption of a short, all-out war. No draft-war capability is claimed.

Absence of Pilot

Some cost and performance advantages are derived from having the pilot behind. His absence eliminates the weight and cost of all the systems needed to accommodate him plus fuel and equipment needed for the return flight. Since Bomarc will carry an controlled landing-in design could concentrate on producing a high speed airplane without compensating accommodations and structures to get low speed performance.

USAF and Boeing proponents of the Bomarc concept claim it will outmaneuver a manned fighter because load factor limits are set by structural rather than human limitations. They concede this is probably not too important a factor

MISSILE ENGINEERING



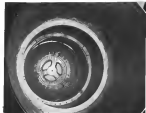
TRAINER Bomarc missile (left) at Boeing, Harbor Island, Seattle, shown in service with Airport General Electric hoist as half fully gas hoist. Nozzle is unrolled, instant launch. Production Bomarc (right) move down final assembly at new Seattle plant.



SCHOOL of Harbor Island provides Bomarc (left) and missile launchers providing complete simulated flight. Bomarc space-based shifter (right), with load again on and to simulate heavy wave load, is fitted with IM 99 solid rocket boosted Bomarc.



PULLING of IM 99A shows even loading and fitting into acid which acts as an oxidant for the liquid rocket engine booster tank. Missile can be stored heated for long periods.



PERK TANK interior (left), tank ends are milled from titanium.



Boeing is experimenting with explosive forming for tank ends.

New!

Fibrous Silicone Rubber

- high permeability
- excellent compression-deflection
- excellent compression set
- -65°F to 500°F temperature range
- good tensile and tear strength

CONHlastic FSR is a new and unique silicone rubber product developed by the Connecticut Hard Rubber Company. It possesses many useful properties superior to silicone sponge and foams, and should be extremely valuable for such applications as shock and vibration isolators, thermal insulators, high temperature gaskets, pressure moldings, etc.

The unusual and random orientation of silicone rubber fibers as shown in the background give **CONHlastic FSR** good tensile and tear strength, high permeability, very low density, excellent compression-deflection characteristics, extremely good compression set, and a useful temperature range of -65°F to 500°F.

CONHlastic FSR is being introduced in sheets 1/4" thick, 9" wide, 6" long, and in a density of 20 lbs./cu. ft. As applications develop, **CONHlastic FSR** will be made in continuous lengths, larger widths, different thicknesses and various densities in the range of 15-35 lbs./cu. ft.

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Leader in fabrication of silicone rubbers.

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for missions as brief as those flown by Bomber. Despite the high load factors which can be accepted, very little is to be lost at Bomber speeds and altitudes that fuel consumption per degree of turn is considerable and a 180 deg turn would take a large bite out of the small total flight duration possible.

Because of the cost reduction made by eliminating the pilot and the return trip, Bomber can be delivered to its base, less fuel load, for about \$400,000. This is less than 10% of the price of a modern fighter capable of supersonic Bomber's Mach 2.75 cruise.

Timing of the Bomber program was fortunate from standpoint of writing it to SAGE, for the team of Boeing and Michigan Aeronautical Research Corp. almost virtually made up the design team Bomber, began work on the missile only shortly before Massachusetts Institute of Technology's Lincoln Laboratory started development of SAGE.

Completion date for development and demonstration of Bomber A (JM 99A) was to have been Jan. 1, 1959, but it was reached five months early and range and altitude figures exceeded those specified. First of 17 conventional jet-fuel launch units to U. S. is now being finished at McGhee AFB, N. J., and will be ready in September. Service Evaluation (Category III) Tests on being run by 4751 Air Defense Squadron (Model) at Eglin AFB, Fla., and Field No. 9 on Santa Rosa Island off the Florida Gulf Coast. Timing of Bomber program has been going on at Boeing's Everett Island school installation in Seattle for a year. Unit train-

ing has just begun at Eglin. More than 150 copies of Bomber A are known to have been ordered; more the missile went into full production in 1957.

Bomber B (JM 94B) will go to the same USAF base to be activated in late 1960 and all succeeding ones including the two unnumbered Rapid Capable Air Force boost. Condo estimates its two boost will cost \$164 million. A \$180 million order for the B version has already been placed at the U. S. and some contractors have received the order. Bomber production actually reaching 100,000 with a total value of \$10 billion.

This thinking ignores the present susceptibility of air defense systems in Germany, compared with the general deterrents and small air weapons. Air Force and Boeing hopes are for more extensive USAF is asking \$92 million for Bomber site construction in fiscal 1960, rather than the \$222 million planned under Senate Armed Services Committee has lumped it in with the Army request for Nike, reduced the sum by 20% and assigned to Department of Defense the authority to decide how it should be spent.

Bomber A is basically a 15,000 lb. gross weight radio-controlled airplane which is launched vertically by an Aerojet-General LR-35-AG-11 fully guided boost propellant booster and is powered to cruise for two 25-in. diameter Mangoldt RHE MA-3 engines which are used to develop about 33,000 lb. thrust in the cruise phase of the mission. The booster system is an integral part of the fuselage tail section



B-57C is based on Douglas C-124 for shift to Westfield Field, Eglin AFB, Fla., where it will be assembled and given functional test before shipment to Santa Rosa Island.

Product Improvement Program

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(M-65 100 and 2000 series)



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Specimens And American Products Improvements Program makes TORO-SET, which is a wide range of materials — stainless steel, A-286, Stainless Steel, Inconel X, Vaneal, Inconel, Hastelloy C, Hastelloy B, Hastelloy D, Hastelloy E, Hastelloy F, Hastelloy G, Hastelloy H, Hastelloy J, Hastelloy K, Hastelloy L, Hastelloy M, Hastelloy N, Hastelloy O, Hastelloy P, Hastelloy Q, Hastelloy R, Hastelloy S, Hastelloy T, Hastelloy U, Hastelloy V, Hastelloy W, Hastelloy X, Hastelloy Y, Hastelloy Z, Hastelloy AA, Hastelloy AB, Hastelloy AC, Hastelloy AD, Hastelloy AE, Hastelloy AF, Hastelloy AG, Hastelloy AH, Hastelloy AI, Hastelloy AJ, Hastelloy AK, Hastelloy AL, Hastelloy AM, Hastelloy AN, Hastelloy AO, Hastelloy AP, Hastelloy AQ, Hastelloy AR, Hastelloy AS, Hastelloy AT, Hastelloy AU, Hastelloy AV, Hastelloy AW, Hastelloy AX, Hastelloy AY, Hastelloy AZ, Hastelloy BA, Hastelloy BB, Hastelloy BC, Hastelloy BD, Hastelloy BE, Hastelloy BF, Hastelloy BG, Hastelloy BH, Hastelloy BI, Hastelloy BJ, Hastelloy 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Hastelloy UO, Hastelloy UP, Hastelloy UQ, Hastelloy UR, Hastelloy US, Hastelloy UT, Hastelloy UY, Hastelloy UZ, Hastelloy VA, Hastelloy VB, Hastelloy VC, Hastelloy VD, Hastelloy VE, Hastelloy VF, Hastelloy VG, Hastelloy VH, Hastelloy VI, Hastelloy VJ, Hastelloy VK, Hastelloy VL, Hastelloy VM, Hastelloy VN, Hastelloy VO, Hastelloy VP, Hastelloy VQ, Hastelloy VR, Hastelloy VS, Hastelloy VT, Hastelloy VU, Hastelloy VV, Hastelloy VW, Hastelloy VX, Hastelloy VY, Hastelloy VZ, Hastelloy WA, Hastelloy WB, Hastelloy WC, Hastelloy WD, Hastelloy WE, Hastelloy WF, Hastelloy WG, Hastelloy WH, Hastelloy WI, Hastelloy WJ, Hastelloy WK, Hastelloy WL, Hastelloy WM, Hastelloy WN, Hastelloy WO, Hastelloy WP, Hastelloy WQ, Hastelloy WR, Hastelloy WS, Hastelloy WT, Hastelloy WU, Hastelloy WV, Hastelloy WW, Hastelloy WX, Hastelloy WY, Hastelloy WZ, Hastelloy XA, Hastelloy XB, Hastelloy XC, Hastelloy XD, Hastelloy XE, Hastelloy XF, Hastelloy XG, Hastelloy XH, Hastelloy XI, Hastelloy XJ, Hastelloy XK, 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and is not jettisoned after burnout. It has one of the earliest full-payload chambers with an enclosed, automatic thrust vector, which can be used because of the brief burning time.

Propellant combustion is initiated by fuel coming out and oxidant and JP-8, a mixture of JP-4 middle-cut gasoline and unseasoned diesel oil, is drawn. Propellants are fed by helium stored under 4,500 psi. Booster ignition is provided by filling the fuel line between tank and chamber with a starting slug of oxidant before it should separate from the JP-8 by a hermetic diaphragm. Nitro and the unseasoned fuel are an exceedingly treacherous combination.

Aircraft Booster

The Aerojet liquid propellant booster is also used without the enclosing arrangement and with a slightly beefed-up chamber and nozzle to permit work on the Paquet SNAKE and SNOOT high speed test tracks.

Maquardt RJ43 motors and Borene A for cruise propulsion burn 50 seconds gasoline and are started by separate magnesium liners on flames in the combustion sections. Starting

flames are automatically ignited about five seconds before lift-off. The motors start at subsonic Mach numbers, RJ43s use no vanes, primarily in the inlet duct and maintain thrust position by fuel flow control. Borene reaches its maximum speed of perhaps Mach 3 at booster burnout while it is still going straight up. Longitudinal center of gravity range is obviously of very little importance during the vertical phase of flight as booster propellants are stored in the forebay tail section for all of the normal cruise course of gravity and the vehicle does not begin to program over into level flight until booster propellants are expended and CG will be in acceptable range.

Borene forebay has a high density ultra-thin 16:1 Lang, pointed nose-down cone cone is of spun glass but Boeing engineers say that aerodynamic heating is not a problem. Propellant tank walls are also forebay skin. There is no oxidant diffusing in the tanks. Tank ends are rolled titanium hemispheres. Boeing was in experimenting with explosive burning of the tank ends. Wiring and plumbing ran along the top of the forebay in a magnesium tray. Warhead section also is also

progressive. Airframe components are pressurized to neutral dynamic values and temperature conditioned by a small ammonia refrigerant.

Borene II, now entering the flight test phase of its development at Cape Canaveral, has been given a Thiokol solid propellant booster, which, like its liquid propellant predecessor, remains a part of the forebay after burnout. Control and stability during the first seconds of flight will be provided by a jetvector attitude vane like those used in Lockheed Falcater and Northrop S-41-63 Scout boosters. Mid course guidance for Borene II will be delivered by a pair of improved Maquardt RJ41 MA-7 motors. Better motor design and more natural space for fuel mass available in use of solid propellant booster will increase the stage from 250 feet to about 450 feet in. The modified RJ-45 will also increase speed and altitude figures. In the Lockheed X-7, the RJ-45 has flown in Mach 4 and more than 100,000 ft. Borene II is JP-8 rather than 80 octane. It simplifies logistics slightly, since it is more plentiful at USAF bases.

Readiness Status

Borene IM-98A is designed to be kept on two minute readiness indefinitely and can be brought up to within 30 sec of launch and enclosed rapidly without requiring an manual intervention. The launch can be canceled right up to the moment of booster ignition. Two minute readiness is better than can be had from manned fighters and Boeing officials claim that essentially all the missiles can be held on that status continuously.

The cost made for area defense weapons such as Borene and missile interceptors is founded upon the ability to use three longer range to intercept incoming threats from the target than can point defense anti-aircraft weapons. Longer range also means a defensive cost of given size can be protected by a smaller force and there is some hope for battle government between branch and intercept in which to make last minute adjustments as tactical plans. Industry and USAF proponents of area defense estimate that for an equal probability of survival, a target complex can be protected with interceptors for as little as 35% as much as it would cost to use point defense.

Kill Probability

Boeing officials claim Borene offers a higher kill probability and better survivability rate for low courses than manned fighters. An estimated kill probability of 83% has been published for a Borene test series. Manned fighter kill probability is usually estimated at something over 35%. Any unannounced

GENERAL ELECTRIC



T58

The T58 now in production, delivers more power per pound of weight, consumes less fuel per hp-hr than any other turbojet flying today. Guaranteed at 1050 shp, 6-4/4 SFC, this 271-pound GE turbojet powerplant has high response, its high performance, ruggedness, and reliability. Now on test is the 3750 shp Easystart growth design.

T64

General Electric's T64 is a turbo-propeller/turbojet engine in the 5000-hp class. It is a compact, versatile power package for many uses, in land-based aircraft or as a power source for radically new advanced configurations. Now on test, General Electric's T64 engine is confirming an exceptional performance advantage.

J85

GE's powerful lightweight J85 turbojet is a 3000-hp thrust class engine designed to provide superior cost dollar savings and performance advantages for missiles, drones, small and medium sized aircraft. The J85 is being flight tested in McDonnell's "Shrike" design missile and North American's T39 subsonic trainer.



BORENE IM-98 will be launched in the ground for long tests at Lemon AFB, Fresno, Calif., Wash., or there with model. Borene was designed by Boeing Phantom Aircraft Div.

From hover to Mach 3 ... reliable performance

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FLIGHT POWER SPECTRUM



CJ-805-3

G.E.'s commercial counterpart of the military J79. Rated in the 10,000-lb-thrust class, it provides a 4:1 thrust-to-weight ratio. Now being proved in extensive flight test programs, the -3 will power Convair's 880 jetliner. General Electric-built engine reverser-suppressors on the -3 produce optimum results with minimum losses.



X220 and CJ-805-23

The first successful U.S. turbofan engine. Designed for near-sonic military aircraft, the X220 combines the proved J79 gas generator with an altifan, provides higher thrust at lower SFC. Its commercial version, the CJ-805-23, will power Convair's 600 luxury jetliner. New turbofan growth models being developed assure long service utilization.



J79

The 15,000-lb-thrust class J79 powers six Mach 2 air weapons, including the USAF F-104 Starfighter, world's record holder for speed, altitude, and time-to-climb. Other applications: USAF's B-58, Navy's F4H, AJJ, F11F-1F, and Regulus II. With over 90% of U.S. Mach 2 flight time, the J79 has demonstrated its ruggedness and reliability.



J93

General Electric's J93 Mach 3 turbojet — still highly classified — will power North American Aviation's F-108 long-range interceptor and B-70 intercontinental bomber. Along with other advanced turbojet engines currently under development, the J93 typifies General Electric flight propulsion progress.

257

formance ... more power and less weight



**TURBOSHAFT
TURBOPROP
TURBOJET
TURBOFAN**



big ears of Nike Hercules

Mounts for radar antennae used by the U. S. Army's Nike Hercules to track aerial intruders and guide the deadly Nike missiles that strike them from the sky are products of the integrated manufacturing and engineering skills of Kelsey-Hayes, working in close cooperation with Western Electric. Capabilities range from prototyping to final production. The manufacturing facilities of Kelsey-Hayes Company in Springfield, Ohio, are devoted solely to the production of aircraft and missile components. Kelsey-Hayes Company, General Offices: Detroit 32, Michigan.



*Nike Antenna Mount
manufactured by
Kelsey-Hayes requires
over 2,000 individual
parts, many of which
are machined to a
tolerance of less than
ten thousandths
of an inch.*

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 LIFT FLAP

...NEWS IS HAPPENING AT NORTROP

Demonstrating the platform of Lins—now, Lightweight Inertial Navigation System—in Dr. William F. Bullman, Vice President and General Manager of Nortronics



NORTRONICS REVEALS LINS... COMPLETE PRECISION INERTIAL NAVIGATION SYSTEM!

A recent demonstration at Nortronics' Guidance Symposium revealed the most advanced precision inertial guidance system ever assembled—LINS—Lightweight Inertial Navigation System—includes platform, platform electronics, environmental control and computerized system weight, slightly in excess of 100 pounds. Engagement volume: less than three cubic feet.

A novel working hardware LINS complete, precision system for automatic navigation applications to advanced aircraft, drones,

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is ready to fire. When the signal is confirmed that a missile is on standby status, the fact is shown on a digital display before the operator's console at the Direction Center. The operator then sets the FSG-7 line in "Engage" mode. "Engage" mode is "Fire". This is the modern terminology for the intercept point calculated with the information available at the moment.

Information available will include present range, heading, altitude and speed of the target along with the light profile of Bomarc for existing atmospheric conditions. As time passes and the situation changes the engagement prediction panel will vary. When the operator at the Direction Center pushes the "Fire" button, the program timer and electronic launch equipment begins the automatic 10 sec. fire-up stage preparation to launch. The missile gets no external power, draws its own power and completes final checks. The shelter roof slides back, the launch-center raises the missile to vertical and returns empty to the target launch area. Perhaps five seconds later, the launching center and the rocket engine's alcohol engine in the rocket chamber to start the booster. As Bomarc rises vertically, from its shelter, it rolls to point its bay window toward the enemy and as it reaches cruise altitude pulls over on its transverse turn to roll and headed toward its target.

If the target maneuvers, command control signals generated by FSG-7 will turn Bomarc onto a new intercept heading. Identical coded radar beams enable SAGE to direct area intercepts in a computerized small area without confusing their respective target assignments. Cruise altitude is pushable above 50,000 ft. When the missile is near its target, FSG-7 will command it to pitch over and dive upon a target lower than itself is seen to reach a higher one. After the Westinghouse Target Service automatic guidance locks on Bomarc will report further commands from FSG-7 and will be written off the board at Direction Center.

SAGE Bomarc has 10 feet wingspan from the Boeing B-27 bomber.

WS-138A Review

Washington—Douglas Aircraft Co., Inc., has been recommended by a USAF source selection board as prime contractor for the WS-138A in limited ballistic missile. Recommendation was made recently by key USAF officials but was not. Douglas, teamed with General Electric Co., was one of 14 contenders (AW April 20 p. 21). Missile would use the North American B-70, General Electric B-70 and Boeing B-70. Contract is believed to be about \$100 million.

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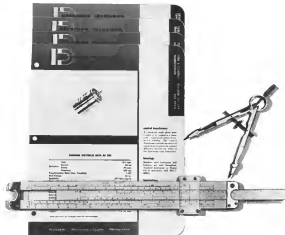


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Ion Thrust Project

New York—B. F. Goodrich Co. has joined with High Voltage Engineering Co. to form Goodrich High Voltage Associates, Inc. for work on ion propulsion devices.

Development of a laboratory ion thrust unit is now under way at High Voltage's Bedford, Mass., plant. New facilities will be headquartered at Burlington.

B. F. Goodrich's Aviation Products Division, has been named chairman of the board. A John Cole, vice president and director of applied physics for High Voltage, has been named president.

Goodrich and Goodrich High Voltage Associates also will work in the field of power generation from nuclear and solar sources.

to the target powered X-10 test vehicle. The test is a fairly sophisticated maneuver because it requires that a conventional vehicle would be completely feasible, though the standard missile will be equipped with the radar warhead. Boreas has two test ranges, each with different target altitudes depending upon target altitude. Its capability against low flying targets is definitely limited by inadequate structural strength in the fuselage and stability of the target itself in order to pick out targets at the point of ground clearance.

Boreas B will be improved for use against low targets by a structural beefing and modification of some type of moving target discriminator on the target radar to electronic clutter. A more realistic view has been taken of enemy intent for electronic countermeasures in Boreas B. On the assumption that it may be difficult or impossible to get a good track on the target, Boreas B has been given the ability to sweep a corridor with its improved target radar and strike any target it finds there.

This means that with extensive reformation it would be possible for a scoutplane to destroy everything in its line in a given area if it concludes that there is no enemy there on the basis of a pass or sample track. It would also be possible to lay a trap of Boreas intercept corridor around the last known enemy position and knock down anything that got out of the band area.

Second test to date for Boreas A was a simulated operational launch against North American X-10 test vehicle from the Navaho ocean missile program. Boreas was controlled by Kingston, N. Y. SAGE center 1,500 mi away from the Cape Canaveral launch site. The X-10 was launched from the Cape, flew over the Atlantic and turned back a week at

tack on the missile line at a speed of 1,600 mph (Mach 1.4) and altitude of 45,000 ft. Boreas made its attack from a higher altitude. Elapsed time from launch to intercept was 10.5 min. If the intercept had been at a distance range of 100 mi, the reaction distance would have been about 12 min.

Since it may be desirable to run Boreas from overseas bases where there is no equivalent to SAGE, the weapons system includes a Westinghouse GPA-15 controller computer to substitute for the SAGE. If operating capability was reduced from overseas to domestic, the number of lifts probably would not be reduced 50%.

Project Boreas basic air soft since they are considered as unlikely target for enemy strategic forces, but there is some indication that this system may be revised as USAF is running cost effectiveness studies on the advantages of intercepting or dispersing Boreas vehicles. Great disavowals of support that a reduction in cost which support equipment, personnel and facilities can be shared among the missiles.

On soft Boreas basic, the home-laying and support area is immediately adjacent to radar units of missile divisions. It includes an assembly and maintenance shop, test and power building, compressor building and propellant storage facility. Assembly and maintenance building is the heart of the support area. Missiles are stored and assembled there when the equipment is established and most of the periodic checkout and maintenance are done there. The Service Operations Center, where the equipment controls workshop of the missiles in the division and reports available to SAGE is also located in the A & M shop.

Standard nondestructive modular maintenance philosophy used in Boreas is based upon a table of automatic, self-checking Operational Test Equipment. Some of the checkout and maintenance functions are performed in the shop but most of the heavy and complex equipment remains fixed in the A & M shop. A mobile inspection component van and radar target truck are used in many of the "one-day" checks upon the missiles in the division. In Boreas B, the maintenance check cycle will be extended to 90 days.

Maintenance recycling of a missile through the A & M shop will cost every six months for Boreas A and every two years for Boreas B. Cost decrease sheets and maintenance cycles can be structured in the proposed missile units because of the use of a self-propelled launcher. There is no need to pump and check tanks and propellant lines which rather complicated from the overseas base.

The van carries a finished checkout set and a launching equipment checkout set which automatically sequence functional tests of missile systems, launch and launching equipment. The launching equipment checkout set performs a self-check sequence of 500 tests and then performs another 500 tests upon the launching equipment.

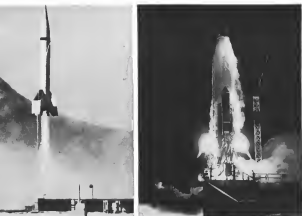
The entire performance requires about 20 min.

The on-board servicing is carried out on a non-stop line about which the missile programs in its most thorough field maintenance operation. Six positions are remote entry bay, two disassembly and repair maintenance servicing stations, a propellant test station, hydraulic test and assembly station and a launch test station at which the missile is placed upon an ejection sled to a functional checkout set which can simulate an entire mission including combat surface responses to radio command signals, radar detection, etc. There is a separate support test room in which the full control system can be checked. Missiles are moved from station to station in five A & M shop bay on a transport vehicle. The number of stations will be reduced to two for Boreas B.



Nose Cone Recovered

The Atlantic nose cone is recovered by USAF from a missile shot from Ascension Island in the South Atlantic. This was the first nose cone recovered by USAF after reentry into the atmosphere. Missile had been launched from Cape Canaveral, Fla. and traveled 5,000 mi. down range. Flotation bag is water, now once was suspended from it 19 ft below water's surface. Nose cone was returned to Avon by analysis of effects of heating during 15,000 mph reentry.



MX-774 test vehicle is mated at White Sands, N. M., in 1945 (left). Atlas XCRM at right was mated Dec. 16, 1958.

Atlas to Play Major Space Booster Role

By Richard Sweeney

San Diego—Convair Atlas autocombustion ballistic missile—designed on concepts conceived almost 15 years ago—is nearing operational status and will continue to play a major space booster role for some time to come.

Three new missile design philosophies introduced in Atlas include:

• Thus will support tank structure where permeation is the key to required structural strength.

• Enabling engines to control flight path of aerodynamically unstable vehicle.

• Separating nose to stern payload through air-to-air structure, eliminating need to warn about the air-to-air payload.

As a strategic deterrent type of weapon, today's Atlas can carry a thermonuclear payload over ranges up to 7,500 miles, as sufficient to hit any target in the USSR from any location in the United States.

But advances in propulsion and struc-

ture fabricating techniques, which have come along as functions of time down the learning curve have pushed the missile's inherent capabilities to where a payload twice the weight of the design standard could be fired to the remotest possible point on earth for the delivery mission. Additional growth potential exists on the missile, obtainable through propulsion and other system refinements. Atlas has been cast for these space work roles.

• **Cokeless**, a guidance consisting of Atlas plus a high energy upper stage using liquid hydrogen and oxygen. This, as compressed back into missile applications, would enable Atlas to now move into 10,000 lb payload to any point on earth, i.e., range of at least 15,000 mi. Convair also could boost a substantial payload into orbit (the word orbit used here refers generally to a distance above the earth of 100 miles or more) in orbit. Convair's potential is as a useful deep space probe, carrying instruments, payloads millions of miles, as controlled

with near space travel, such as to the moon.

• **Vega**, which is Atlas with a Vanguard first stage engine on top. Later, addition of a 5,000 lb thrust storable liquid oxygen tank, further boost this combination's potential. Advantage of Vega is that it can be available by the fall of 1964, who would use much of the time line looking at the late Convair to facilities production, changeover Vega is a near-space probe and will not handle the payload Convair can.

• **Maturo**, National Aeronautics and Space Administration uses as space probe, in which Atlas alone will power the manned flight into the orbit together. Here, the Vega only combination can be used in preliminary test work, that is Atlas with a Vanguard first stage on top. NASA is to build the first hot instrumented test vehicle before. McDonnell capsules are launched.

• **Dyna-Soar**, Convair package in the booster for Boeing-Dyna-Soar payload,

after a shogun from the original acid propellant propulsion system environment. Additionally, Bell-Martin Dyna-Soar team is keeping a close check on Atlas for possible incorporation into its program. Although the original plan was use of Titan, in Dyna-Soar, Convair would be tapped by that named test stage.

• **Sooty**, at WS-1175, the maximum range vehicle, for which Atlas will be the booster vehicle.

• **Miles**, a family of satellites which will accomplish global reconnaissance and surveillance, with Atlas again the primary booster vehicle.

Now Atlas was, which are included in NASA's general space plan (AW Nov 2, p. 19), include Atlas with Bell Booster on top and Atlas-Able, Atlas with the Vanguard second stage and Allegory ballistic laboratory's solid propellant third stage of Vanguard.

Convair Studies

Convair has made additional studies with Atlas, using many considerations, to fully exploit the missile's potential.

Included in these have been studies which indicate, according to Convair, that a cluster of three Atlases would be very close in performance to the just V, the Army Ballistic Missile Agency cluster of North American Avionics Rocket-dyne thrust chambers of the Atlas booster chamber thrust also, which is being designed as a million pound thrust engine.

An extension of this is a cluster of three Atlases, and a cluster of the high energy upper stages of Convair on top, with a single Convair high energy stage on top of this. This should be useful for significant space travel claims. So another combination in the ARMA has been proposed, cluster, topped by a Convair (Atlas and high energy stage).

Convair also is not neglecting applications for work further down the line. In these studies, high energy upper stages with up to 140,000 lb thrust and using propellants such as dinitrogen tetroxide and fluorine hydrazine are being considered. For this, Atlas as a booster would have an thrust value for launch equal to some 500,000 lb by modification such as replacing the motor chamber with a booster chamber, all three chambers with a thrust level approximating 200,000 lb each. Booster chamber could replace motor chamber overall envelope area of both together to be very close despite the difference in the combustion chamber size, and expansion ratio.

Indicative of variations possible with staging, Convair studies showed that an Atlas topped by a Thus, and with a Convair high energy stage on top of that, was about equal to a Convair combination alone. An arrangement of the high

Atlas Milestones

• **MX-774** Target, contract awarded Convair in April, 1946, first vehicle static tested in November, 1947, and first flight on July 13, 1948. Incorporated this will support tank structure, enabling engines for control, separating nose cone.

• **MX-1595** Project, contract awarded in January, 1951, for overall system study and component design "leading to" an autocombustion ballistic missile. One engine used this will back, 52 ft in diameter, was fabricated according to Convair specifications by Solutia Aircraft, was used for several years in static test of Atlas, even after the missile structure became 30 ft, when the tank became in effect, a 12 scale model.

• **WSA-175**, the Atlas contract signed in

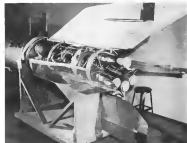
January, 1955, for the missile in two cells to test. First Atlas flight, June 4, 1955, altitude 48,000 ft, 25 mi, below a maximum altitude, and returned 90% of test objectives prior to destruction.

• First complete Atlas fire in September, 1958, incorporating all elements of the missile except the warhead. Current significant weight of environment. First full stage Atlas flight, Nov. 28, 1958, where missile launched on parabolic trajectory toward Accretion Island after launch from Cape Canaveral, Fla.

• **Project SCORP**, where Atlas 108 was placed into orbit carrying an Army developed communications package, on Dec. 16, 1958.



ONE of three MX-774 vehicles is mated. Vehicles were built to test concepts used in Atlas.



PROPULSION section of MX-774 vehicle comprises four engines of 2,000 lb thrust each.



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energy input stage at both ends, re-both is very close. In the third stage vehicle. This weight reduces takeoff performance to a point where the firing of the Thor barely overcomes the vehicle, but by its weight in the launch vehicle.

During its development flight test mode, Atlas has progressed through several major model changes.

• **Atlas A** First Atlas launched was No. 4 outside of the 3 configuration, which had booster engines only and a heavy load of instrumentation. Atlas A flew for 23 sec before being destroyed by the range safety officer, who shot 90% of the flight's objectives. Flight occurred June 11, 1957.

• **Atlas B** Configuration had everything about which the operational mode would care, with instrumentation in weight where instrumentation placed such things as the warhead. This model also carried extensive instrumentation and was termed the operational prototype model.

• **Atlas C** was a refined model, its payload was more closely packed, it was somewhat heavier at takeoff than the earlier models and had a slightly lower takeoff acceleration. The C model carried instrumentation, but to a lesser degree than the A and B models. In addition, this model could travel approximately the design range, making it to be used in connection with the design stage, such as at Aerospace Laboratories. First follow-up shot with Atlas took place last December from Cape Canaveral, Fla., looking out for the Atlas flights up to one.

• **Atlas D** is the operational type, the first of which was fired May 18 from Cape Canaveral. Since it will be delivered to Vandenberg AFB, Calif., and be used in the training mission, Atlas D will carry more instrumentation, warheads, that required to take back information to the firing range of how well their effort has gone. The instrumentation is about one third that of the original load. However, for D model Atlas is designed to carry up to 10,000 lbs. of instrumentation. Repli-Kote Mirrors are also easily fabricated. If you are working on tracking and guidance systems—or any system employing reflective optics—durable, lightweight, precision Repli-Kote Mirrors are your greater design and production freedom. Let us help you make the most of Repli-Kote Mirrors in making a better product of lower cost. Address inquiries to Repli-Kote, Singer-Broderson, 815 Franklin Street, Bridgeport, C. Conn.

• **Atlas E** will be the totally operational model. It will have much reworking of the warhead's equipment in the later part of better maintenance. It will carry all essential guidance from the start.

Base representation for Atlas E will differ from those of the D model, due to guidance systems, among other things, and it is possible that D model base may be introduced to use the E model. In the normal course of events, D models will be used up to be used in training, maintenance, as well as testing flights, which could result in all operational use being equipped with E models eventually.

Atlas started in one hall of a proposal that Consolidated-Vultee Aircraft made to U. S. Army Air Forces in 1945 for two planes, capable of carrying 1,000 lb. One was the light, the other, the other a subsonic turbo-propeller engine.

The proposal became a contract, awarded in April, 1946, for Project MX-79. This called for a three-phase program, the final phase being an intercontinental ballistic missile.

Starting point of missile design of that day was the German V-2, but some elements of its design were unacceptable for the intercontinental mission, for at least two reasons.

• **Engine model** was not refined to protect the payload. Possible with the short range of the V-2, but that was clear. It was required for a 1,000 mi. missile which would have to go much higher and faster.

• **Aerodynamically stable** in the atmosphere, the V-2 rocket engine, control was provided by movable vanes in the exhaust. These exhaust effluents was questionable, and it definitely was known this significantly lowered rocket engine's efficiency.

First phase in General's program called for design and flight test of two types of vehicles. One was a vehicle capable of Mach 5, the second was to be capable of Mach 15.

Mach 5 Vehicle

Detail design of the Mach 5 vehicle program started in June, 1946, and it was in detail design was started that Karel J. Bossert conceived the idea of the thin wall mirror test. Bossert's reasoning was that since pressure had to be maintained on propellant to provide a pump head and prevent cavitation, then allow this pressure to go higher and support the structure. In drawing pressure, the predominant load left to the tank, the material all was stressed for tension and the overall combination could be lighter than a conventional structure.

At the time of the design, Bossert and F. R. Wernick conceived using narrow thrust chambers for control rather than the jet nozzles. During the first test into Mach 5, wall was about 50 percent of what 1970 was, in the design of the wall. The propellant was cast, after the

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came into being at this time in the most hectic areas of getting the product back through the atmosphere.

These demands were contained into the Mach 5 vehicle design, and the machine had its first static test Nov. 14, 1947. This vehicle was 34 ft long, 7.5 ft in diameter and used 538 lb of ramjet fuel. As its scaled-down vehicle structure, in the best strength capabilities, ramjet engines. In gross weight it weighed 4,000 lb.

Power was supplied by four General Motors X-1 rocket engines, which had each developed 1,000 lb thrust each and used a pressurized fuel system. Design engineers aimed the thrust level to 7,000 lb per chamber to give the missile 5,000 lb total thrust, and a pressurized fuel system was incorporated. Tailoff acceleration was 1g.

The aircraft had aerodynamic fins but also used movable engines. The four thrust chambers were operated in pairs perpendicular to each other, and each pair rotated in two axes.

This vehicle was intended to prove the principles of a free roll integral tank structure with movable engines controlled by autopilot. Max. velocity to be 15 of these vehicles in this phase.

In Feb. 1947, the MX774 program was terminated in effect when there was no ballistic missile money contained in the Fiscal 1948 budget.

However, funds on hand already earned through the construction and flight test of these Mach 5 vehicles, which became known as the MX774. When the first flight was completed, General Lee proved that the then well-proposed integral tank, movable engines and spreading nose cone ideas had obtained satisfactory aerodynamic load data on scale.

When MX774 was out, the second vehicle in the family was in detail design. It was to have had two stages, the first using four thrust chambers of 70,000 lb thrust each, the second stage using one 10,000 lb thrust engine. The rocket was to be used in certain stages, since its design velocity was to be Mach 10. At this time, nose cone developments were to be shockwave tests used, nose profiles of flat disk, von Karman in this respect, resulting in two better aerodynamic shapes being specified.

At the end of the MX774 program, USAF asked General which part of the value control control guidance system planned for the KRM-1 was the most difficult. General said it was the electronic which tracked the missile to give the data which was fed to the computer, and formed the base on which calculations were made of path and accuracy corrections to keep it on proper trajectory. Calculations were based on data from the tracker were

reflected in results of autopilot, in the radio-controlled portion of the flight.

This tracking element, which became N2USA integral predictor system, (AWF) Feb. 5, p. 45), was headed and was pointed by USAF through the period 1945 to 1951 when ICBMs were created. During this period, General kept theoretical studies of ICBM problems going with its own funds. More and more studies had "what-if" engines in the engine required to do the job was as much as available when needed.

In the studies of this period, General proved mathematically that ICBMs were feasible economically, but the Circular Error Probability (CEP) dictated by warheads available was rather small, even in today's standards.

Even with high Mach numbers still were indicated for security, more time studies indicated very sharp nose, such as 5 deg half angles. Heat inputs in the region were in the order of 50 to 60 million Btu/sq ft/hr, an almost insupportable condition.

First Yemins

During the 1949 studies, the idea of using small rocket engines for free roll control of ballistic missiles appeared, the first use of vector engines. These small engines also were guided in design concept, which was proved out on Atlas later.

In January, 1951, Wright Air Development Center awarded General a contract for Project MX1591, which was for the study of over-all options and development of components "leading to" the design of an intermediate ballistic missile. Working under the contract, General developed experiments which proved the study principles but also were producible looking to the day when the program required a new ICBM contract.

While studies made during the 1945-50 period utilized rubber engines, in the fall of 1951 a design was completed which was predicted an use of seven moving thrust chambers and a solid rocket booster. Missile was to be 12 ft in diameter.

The engines were those developed North American Aviation for the Nostra program, with a base diameter capable of about 118,000 lb thrust at that time. The decision was agreed on all around that it was best to go ahead with what was available rather than develop new engines.

New Configuration

In March, 1952, a new configuration was officially established, using four chambers of the Nostra type, a 12 ft diameter tank and with an official period the same as before. Chamber thrust levels for this configuration officially remained 118,000 lb each.

In this design, a switch in material

was made from aluminum alloy, which posed problems in fabricating different alloys to obtain desired efficiency to structural steel. This switch, which pulled up some weight, also had the effect of giving the design a factor of safety in the fat parts of the trajectory, where aluminum design was anticipated in the time of an elevated temperature condition.

Headcase was fabricated for this configuration, a tank was put together in Solar Aircraft Co. working to General design. This tank was used to intensify over the point to static test at General's Pt. Loma facility, where it was used in investigations of vibration, heat, autopilot control systems.

At this time test, destruction limits for the period were calculated, allowing a reduction in security Mach number. However, the nose speed assumed in the region later considered impossible, and produced heat inputs on the order of 38 million Btu/sq ft/hr. But since laboratory simulation had reached values of 16 to 33 million

Btu/sq ft/hr, inputs the problem was judged solvable; but extremely difficult. General made more design for flame requirements approximately a 124 deg half angle, with work centering on both recuperation cooling and utilizing material techniques to protect the payload.

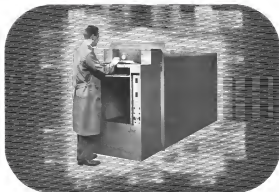
Although design parameters and General's approaches remained firm conceptually for quite some time, first official reduction toward today's Atlas configurations did not come until August, 1954.

Studies Continued

General continued his studies in the period 1951-55, as an increasing heavy emphasis was being given to more schemes and configurations receiving attention. Included were low density staging, parallel staging and combinations of the two known as tandem. Rubber engines were used in these studies. One total consideration in



WEAF-COYBARE: Atlas intermediate ballistic missile is equipped with an ablative type nose cone designed to survive reentry after launching from Cape Canaveral, Fla.



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strong studies was ultimate ignition for second stage. It was thrust in the same hour that it possible.

An approach to the staging problem which looked promising at first was an aerial configuration, with the substage being the booster and having the horizontal cross section of a doughnut with the final stage carried in the doughnut's opening. However, problems of human ingenuity, or bounding and bounding, led to the loss of the substage did not, caused it to be dropped.

As the program worked on overall ICBM problems during the 1951-1952 period, Cooney came to some conclusions, and in June, 1951, recommended changes in requirements which were:

- Impact Mark number 10, reduced to 10,000 ft, and test task technique be used to protect the payload. How task was taken to be within the state of the art.

- Allowable CEP be extended to twice the existing limit, to speed guidance development.

- Payload weight be cut about a half.

Cooney, realizing these changes concerned the weapon system's capability, argued that they be adopted in the interests of getting an ICBM later, and that they should be compensated for where possible and losses accepted where unavoidable.

Changes Incorporated

These recommendations were later incorporated into official changes of direction of the program.

During 1952 and 1953, two periods for action which significantly affected the Atlas program occurred.

Although ballistic missiles were still officially being designed around nuclear warheads into 1954, one of the most vital factors in missile technology started undergoing a tremendous change when a thermonuclear device was integrated into the Pacific in November, 1952. This reduced design of smaller size, lower weight but much higher yield warheads for ballistic missiles was possible. This was proved when the first thermonuclear weapon was fired May 11, 1954.

Second occurrence was the establishment in 1955 of the Air Force Strategic Studies Task Force Committee under Dr. John von Neumann. This group argued acceleration of Atlas program and continued Cooney's design approach, but recommended a major change in management concept of the program to achieve an operational ballistic missile earlier than had been planned.

Air Force approval of the Navy-Navies committee recommendations in May, 1954, and aimed to align the Air Force program along the same line set forth by approximately the same time, until 1954. Cooney's recommendations of 1953 concerning ICBM design acqui-



Swedish Test Air-to-Surface Missile

Swedish Type 304 air-to-surface missile was developed as one of more strategic cross aimed missiles on the Submarine A12's stock aircraft. In top photo, just taking time on missile has ignited and shrouded in smoke. No exhaust can be seen from control surfaces. In middle photo both tracking down on its own Type 304 strike toward target. Bottom photo shows cylindrical configuration with open nose and tail sections. Geometry is correct, with delta wing air fitted with vertical fins for directional stability. Forward suspended sections are for entry and exit control. Speed is about Mach 1.3. Overall length is 15 ft., wingspan 5.5 ft. Range is 23 mi. Missile is quality production by Royal Swedish Air Force, was developed by government contractors in cooperation with industry.



ABOARD THE NAVY'S F4H

COLLINS ELECTRONICS

McDonnell's F4H-1, Navy's first supersonic, twin-jet, all-weather fighter, adds a new dimension to the Navy's striking power. For the vital functions of communication, navigation and radar identification, this potent new Weapon System employs the Collins-developed AN/ASQ-19(XN-1).

First system of its type to employ the modular design concept advanced by the Avionics Division, Bureau of Aeronautics, the AN/ASQ-19(XN-1) has proven the capability of this concept to meet the requirements of supersonic Weapon Systems yet retain the many advantages of standardized production and field support.



Paving the way to the smooth integration of the AN/ASQ-19(XN-1) with the F4H-1 aircraft were: close teamwork of Collins and McDonnell engineers; . . . delivery of prototype models well in advance of requirements; . . . thorough laboratory testing of the entire integrated CNI system from antennas to indicators.

Extensive testing in an F3H test vehicle and successful completion of the F4H-1 initial flight test program have proven the capability of the AN/ASQ-19(XN-1) to provide interference-free operation, high performance and reliability — a major step forward in Weapon System electronics.



COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA

ments were acknowledged, and changes started to become official.

In August, 1954, Western Development Division of Air Research and Development Command was organized to manage the ballistic missile program. As Western Development started its management of the ICBM program, the concept was Air Force as weapon system manager while industry contractors worked on various parts of the weapon system under separate contracts simultaneously. For the technical staff of Western Development, USAF contracted with the firm of Kaman-Wood, designer for technical services, a role which later was expanded to have the company provide technical direction and systems engineering for the ballistic missile program.

During the late fall of 1954, the Atlas program generally looked like this:

- Missile itself was changing from the 6-segment, 11 ft. dia. configuration and gross weight of more than 500,000 lb., to the three chamber stage-and-a-half, 10 ft. dia. missile which weighed considerably less.
- Payload weight, which Convair had hoped coming in hot a year earlier, was reduced to less than what Convair had recommended. Officially, the payload weight had remained fixed for several years past, although in the interim as modified airframe development had been made of weight reductions and weight yields which had been taken into consideration in calculations. What had been verbal agreements on payloads obtainable with the then-current technology advanced were formal and serious calculations to which several drops in weight and yield.
- Various portions of the missile development was to be given to a new group of aerospace contractors under new management concepts, and part of the contract was signed in early 1955.

North American Aviation's solid engine division, Rockwell, Inc., was awarded the major contract for the Atlas propulsion system in August, 1954. Basic booster now was to be two thrust chambers of the Navaho type, but using IP4 liquid oxygen-propellant instead of alcohol-liquid oxygen, with a design thrust level of 131,000 lb. each. By December, 1954, the design thrust level for booster chambers had been raised to 150,000 lb. each. Development time was to be squeezed for the new 68,000 lb. sustainer chamber, but it was judged that the new engine would be ready when the missile was. From 1952 until the time, North American was waiting on development of the five chamber engine as a subcontractor to Convair.

Atlas now competitors for guidance and navigation, in both of which Convair participated, contracts were awarded

to General Electric for the now official subsonic re-entry, heat sink, nose cone and a second contract was given the same firm for development of radio-controlled guidance system.

Convair, which received the airframe contract, had received official notice of induction of Atlas design starting in August of 1954, when the CEP was enlarged and subsonic re-entry was fixed.

Receiving its contract in January, 1955, the airframe and flight test work, Convair saw its first Atlas, Missile No. 4A, fly for 27 sec. June 4, 1957, a first flight in which 90% of the test objectives were achieved. Flight date was not 6 weeks behind objective established when contract was signed 24 years earlier.

C-130 Transport Modified To Launch Firebee Drone

Aerial launching system for the Ryan Firebee jet target drone, utilizing Lockheed C-130 Hercules transport, is under development by Boca Aircraft and Lockheed Aircraft Corp. Hercules modified to carry four Firebees has made its first flight from Delton AFB, near Mexico, Ga., with the drone mounted under the wing. Two more C-130s are being modified for sequence testing at Eglin AFB, Fla.



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AERONAUTICAL ENGINEERING



SAAB 37 VIGGEN receives winter testing at Lulea, Sweden, no less 60 mi north of Arctic circle. Bomber includes operational mission.

Swedish Air Defense, Part III:

Sweden Operates Air Base Near Arctic

By David A. Anderson

Lulea, Sweden—Eight months a year, 24 hours a day, the Royal Swedish Air Force fights the winter weather at this base 60 mi. north of the Arctic circle. From October to May, snow-plows and maintenance men on the go around the clock, keeping runways and taxiways cleared, plowing out and smoothing before-landing strips, opening roads and open areas.

On the flight line, technicians work in their well-lit heated garages on planes tethered to the apron with steel cables, because hooks don't hold on ice. Operational flights take off and land on slippery runways, sometimes on glass ice, with the runway lights not working at the end of the movement area. This base, in total darkness for three days a week, has had to develop a new aircraft and equipment as well as thorough testing of snowmobile operational missions.

Lulea also is the center of a complex of bases, leading out to the north where fighters stand on high alert, their engines running and their pilots

drugged to, ready to roll on word from the control room.

Lulea is a base base for a photo-reconnaissance squadron and a winter station for three squadrons coming north for a rehearsal course in cold-weather operations.

Snow Problem

From October to May, Lulea is subjected to snow. A typical storm could last for three feet of light powder snow on the field. This caused severe accumulations because of the continuous snowplows patrolled maintained at the base.

A single snowplow, 6,500 ft x 164 ft, plus its towtrucks will account for about two million square feet of surface covered about six inches cube feet of snow that has to be removed as it piles up.

Weight of snow varies but averages out at a specific weight between 0.2 and 0.5, which corresponds to between 12 and 16 lb per cubic foot. Total weight of the snow, to be removed from the runway, and the taxipavement is on the order of \$0,000 tons.

Add to this a second meaning, if there is one, or again, and possibly, an ever-greater belching strip parallel to the runway, and over the frozen railroad, and the magnitude of the snow removal job is clear.

Swedish experts in snow clearance have developed a standard type of at track on a snow field. Using plows, blowers and rollers, they tackle the snowfield shortly after it begins and work continuously until the snow has stopped and the snow is cleared.

Plows are of two basic types: either a standard Caterpillar tractor pushing a diagonal plow, or a loaded truck pulling a V-plow with a wing. The truck is driven at top speed to make the heavier or wetter snow in the south of Sweden, but light powder snow can't be handled in this way.

Behind the plow, come the snow-blowers, large units with geared snow loads passing the snow into the center of a cylindrical blower. Biggest of these units, the 276-lb. Snows Vals blowers, can toss 10 tons of snow per minute a distance of 75 to 100 ft.

Finally the blowers are followed by



ROYAL SWEDISH AIR FORCE Each J2C from the 13th Jet Fighter Wing at Norrebro is warned on the line at Lulea from extended power source. Squads of the Swedish Air Force move to Lulea once a year for winter operations. Snow covered is a major operational problem from October to May, and aircraft sometimes take off and land on glare ice.



CLOSER view of the new external power source being used to warm a J2C is shown above. Below, a Royal Swedish Air Force pilot sits in one of the short three-man sled sleds parked in part of an inverted lot. Standard one-man sled seats are bad and shifter parachute on ground behind pilot provides additional covering. Second sled (left) is spread, outside speed out near pilot. Second sled is in center foreground.



large compacting rollers towed in a train. This rolling technique, and one entirely up to compacting snow on roads, is applied in a different way to runways. The rollers are towed through the piled-up bank of snow at the edge of the runway, hauling down the sharp lines into a smooth contour. The last three basic advantages, a provision of clearing the snow bank across the runway, it limits or eliminates damage to an assault that runs or skids off the runway, and it compensates the runway by eliminating the shadow from the shoveling edge.

One of the problems which rose out of snow removal was the necessity of the job. Drivers made gas after gas along the runway at low speeds, for long periods of time, in heavy snow, and often at night. There was no security to provide protection of vision, there was no change of content, no change of job just the unvarying drive up and down the field, unrelieved by snow.

But morale got a boost and the driver's attitudes changed when they were told simply and truthfully that they were the men to whom the air force depended. If the runway were clear, the planes could operate. Otherwise, they were grounded at home. The approach worked, and a small chat with any of the pilots or drivers gives the driver the immediate impression that they take pride in their work.

What About Ice?

Ice is a completely different matter. At our field we had helpfully across the field apron hanging to avoid the reflecting track which was skidding down, unreluctantly and always toward us.

This underlined the problem. On glare ice, there is nothing that can be done.

Mechanics and ground crew were given up their boots and knee warmers of insulation. Some of the road rollers have tire chains, and also have tires. But chains are only on the apron, where planes are towed and there is a chance of skidding fast. Snow spurs from the chains' impacts with the patches of concrete make for a big fire risk, which is not worth taking.

The use of chemicals for melting the ice means a tremendous expense, because of the cost to be covered and the fact that there are would have to be the most careful. Most of the removing chemicals are salts which corrode metal, and the damage to buildings, aircraft, and the underbelly of aircraft would be prohibitive.

For similar reasons, runway and taxi way sanding is difficult. The risk of jet engine damage due to ingestion of the sand or crushed gravel is too great

Some experimental sanding sanding techniques have been tried, in which the last 1,500 ft of the down wind end of the runway are sealed on the left hand side only. If the pilot sees that he won't be able to make a normal stop in the usual distance, he steers for the left, into the sealed area at reduced speed with engine idling to maintain position.

Sanding the apron is not, not only for runway reasons, but because of the blast damage that would result from engine runway and plane towing.

There is another big problem: engine failure. British don't build jet aircraft, so the airplanes are towed with tow cables to tug into the concrete apron and then held back during ground taxi.

Some mistakes have been made against ice on the runway and apron by using ice as a runway. The pilot was lowered from the runway, and resembles an ordinary sled. In use, it is towed behind a tractor and hauls the jet aircraft into small chunks that are much improved traction for men and vehicles. This technique doesn't lend itself to runway applications, because the crashed jet frames spin constantly and its sharp edges would quickly tear men to ribbons.

When all else fails, there is always the runway bazaar. These acts, installed at the upwind end of the steps, have used many airplanes and pilots. Standard equipment with the Royal Swedish Air Force and 11 other air forces, these British overseas training were designed by the Royal Swedish Air Force and are manufactured by Royal Air Force at Norrebro.

The bazaar went up at all the runways we used, and there were a couple of times when the night of the big night waiting there was a relief. One landing made on a sled, never went more than the distance of the jet in the air and for a while it looked as if we too would get the long-running list of crews and aircraft saved by the net.

You may need to have a couple of engineers to join for the installation, and one engineering officer.

Personal Equipment

Working on the flight line in Arctic weather is tough duty, obviously. No clean house, no house, and no fence to machines. There are no hot hands, regardless of how far the work, because men will freeze rapidly to cold metal in the north, and the operation is painful. If the work to be done can't be done with gloves on, the pilot goes inside a heated area. But the machines are allowed but developed a spraying facility over though thin, warm gloves, and were able to handle small work better than we could with bare hands.

Personal clothing is not chosen. Once standard underclothing and outer overalls, they were lightweight trousers and pants made of waterproof white cloth and lined with glass fiber insulation. The pants hood can be pulled over the head and covers most of the face. Edges of the hood surrounding the face are treated with wool fat, the only material currently known as which the breath will not condense and freeze to ice.

Boots are standard issue of the Swedish Air Force and have a rubber base and felt top. The design resembles somewhat the Eskimo wooden boots, which have heavy soles and flexible uppers.

Boots are not worn and moccasins are very rare in spite of the close ties between the Royal Swedish Air Force and the British Royal Air Force. Shaving is done at night, never in the morning. The reason is that shaving makes off the natural ice secreted by

the glands in the skin. These oils add moisture to the skin and help prevent frostbite.

By shaving at night, there is time for replacement oil to be applied and by morning the face skin is protected once again.

Survival Kits

Personal equipment for survival is checked out carefully as a parachute. Packed into a suit canvas under pilot and observer, the standard Swedish Air Force survival kit contains concentrated ration, instant hot, instant cold, and a pair of moccasins.

The shoes are modern adaptations of the classic "ice-paw" moccasins used in northern countries in many forms for years. They are padded out at the ankles, and are made of a material that is hard and has been proved in the war portion, and one edge of the shoe has been sharpened and is normally pro-



FOUR sleds being pulled across the field at Lulea as part of windbreak light speed weather. Constant snow clearing is the rule for night months of the year.



SNOWPLOW, largest in service with Royal Swedish Air Force, is 150-hp. unit.



ANTI-ECM/ECM countermeasures capabilities of radar for control or guidance returns can be quickly checked in a laboratory or on the flight line on an operational basis, using new test equipment developed by Minuteman Research Laboratories, Inc.

Checkout Device Tests ECM Capability

By Philip J. Khan

New York—Recent investigations indicate that some military radars are vulnerable to severe electronic countermeasures (ECM) because of inadequate design, misalignment or misalignment. Richard W. Harford told the Institute of Radio Engineers convention.

Harford described new checkout equipment, recently purchased by Navy and Air Force, which is designed to quickly test the anti-jam capabilities of radar under a number of different possible countermeasures. Harford is technical director of Minuteman Research Laboratories, Inc., which developed the new testers.

The checkout equipment can be

used both in the laboratory to evaluate the effectiveness of basic anti-jam techniques in a new radar, and on the flight line to evaluate operational readiness of anti-jam capability.

Use of such testers can greatly extend the useful life and reliability of radar for control and guidance systems by showing the true capability for operational checkout during installation and on the flight line, Harford said.

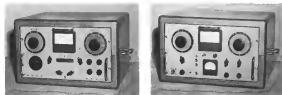
Assessing Condition

Using the testers to evaluate radar can reduce development and in-service difficulties. Harford said. "The equipment is designed to quickly test the anti-jam capabilities of radar under a number of different possible countermeasures. Harford is technical director of Minuteman Research Laboratories, Inc., which developed the new testers.

out, installed-out, modification and/or maintenance on all conveniently. Radar test procedures in general specified the test that anti-jam features were present in the radar and their effectiveness would not normally have been observed until after the outbreak of war.

We also found," Harford said, "that many of the designed-in anti-jam features operated against one another to nullify anti-ECM capability."

A survey of radar manufacturers, air craft/inertia manufacturers who install the radar and users reported by Harford, revealed several faults in testing for anti-jam capability. Although all these surveyed agreed that such tests were "necessary," Harford said, only five percent actually employed such tests.



CLOSEUP of two ECM testers shows Model 315 radar anti-jam/defense (left) and computer Model 413 counter/defense test (right) which simulates jamming targets.

- 35%: Rejection of damped drift by velocity differential.
- 10%: Rejection of damped drift by derivative technique.
- 40%: Ability to track target-gate jamming.
- 35%: Ability to track maneuvering target.
- 10%: Tolerance to self-noise.

Basic Decision

It is necessary to make a basic decision early in the design of a radar whether to attempt to track the target through enemy jamming or whether to shut down and depend upon a brief recovery of post target position, heading and speed to produce false position until the jammer gives away, Harford said.

But in most instances this basic decision is not made and the system ends up with mutually self-defeating anti-jam features, Harford said.

For example, a light range-gate usually is employed to reject signals to noise ratio as a radar is insensitive to such instantaneous automatic gain control (AGC). However, the AGC normally optimizes the radar receiver for the jamming signal rather than the target signal when the jammer is in the range-gate. And the light range-gate prevents the radar's passability to being selected from the true target, Harford pointed out.

ECM, Anti-ECM Techniques

Harford listed a number of different electronic countermeasures and some of the widely known techniques which can be used to counter them.

- **Frequency jamming radar.** Pulse repetition frequency rate, velocity gate, light range-gate, narrow bandwidth in acceleration gate.
- **Damped drift.** Acceleration gate, leading-edge tracking edge lock-on with light range-gate, or velocity differential.
- **Forward-drift drift.** Automatic frequency lock, velocity gate, light range-gate or acceleration gate.
- **Delayed Acceleration gate or impulse correlation.**
- **Range-gate dithering.** Velocity gate, light range-gate, light automatic frequency track at acceleration gate.
- **Roll jamming.** Pulse rejection frequency jitter, velocity gate, light range-gate at acceleration gate.
- **Noise jamming.** Closed-loop rate recovery for correlation, light range-gate for rejected signal-to-noise ratio at instantaneous automatic gain control.
- **Antenna skewing or severe resolution.** Use of monopulse radar.

Analysis of the effectiveness of various anti-jam techniques, Harford said, shows that a velocity-gate in the eyes a test, or slightly superior to an automatic frequency tracking system. Even better is an acceleration-gate, equivalent

to a multi-tracked frequency tracking system.

However, use of these new discrimination techniques demands a good closed-loop recovery and a compensation region about the range gate, Harford said. It requires that designer consider not only the upper limit tolerance for anti-ECM effectiveness but also the lower limits so that noise or voltage anomalies with the radar itself will not cause the radar to track back.

Similarly, automatic frequency track requires that designer look at the rate of frequency changes as to accommodate measures of the target but not sudden departures which indicate a jammer or decoy. This type system also requires a compensation technique to target frequency while subject to noise or jammer perturbation, Harford pointed out.

Harford continued that any anti-jam technique if improperly applied or adjusted, can degrade radar performance against legitimate targets. The radar designer must therefore be very selective in choosing anti-jam features to be incorporated.

Minuteman Research Laboratories has developed test systems which can be used to check the vulnerability of a radar to different countermeasures as do actual operational conditions.

- **Radar analysis-simulator, Model 315,**

provides a simulated radar pulse echo whose range, range rate, range acceleration and pulse rejection frequency can be accurately selected and easily controlled.

- **Radar analyzer anti-jam/defense test, Model 413,** in combination with a Model 315, enables it to simulate a target at any altitude and/or elevation angle, moving at any desired velocity and/or acceleration. The difference between target and antenna position, which is system tracking error, is indicated directly on a meter.

Over all anti-jam capability and performance of the radar can be determined in a matter of minutes using one or more of the Model 315 and 413 in suitable combinations, Harford said. Test signals can be introduced in RF or video. There are some of the anti-ECM capabilities which can be determined using the new testers:

- **Maximum jamming and closing rates.**
- **Tolerance to self-noise,** by tracking at small velocity differential.
- **Bandwidth on large velocity differential** to establish whether range gate can be stolen by jammer jamming, roll jamming or repetitive jamming and whether it will track forward drift drift.
- **Small sensitivity measurement** to evaluate ability to track maneuvering targets.
- **Large acceleration rejection** to eval-

Possible Counter-Countermeasures*

Type of Countermeasure	Other			
	RF Jammer	Light Range Gate	Velocity Gate	Acceleration Gate
Frequency Jamming Radar	X	X	X	X
Damped Drift		X	X	X
Forward Drift Drift		X	X	X
Decoy			X	X
Range-Gate Dithering		X	X	X
Roll Jamming	X	X	X	X
Noise Jamming		X	X	X
Antenna Skewing or Severe Resolution				

* Based on paper by Robert W. Harford, Minuteman Research Laboratories.

site whether system will track damped shaft and certain types of delays.

- Rotational speed time constant measurement.
- Acceleration tolerance measurement with or without shock.
- Susceptibility to glit in other stage accelerations.

- Ability to track in presence of some wave conditions more consistent.
- Velocity tolerances in function of RF levels, as detectors, effects of some parameters in order of forward that

- Acceleration tolerances in function of RF levels, to determine effects of damped shaft.
- Calibration of range and target rate value.
- Optimization of AGC characteristics, range gate width and video levels.

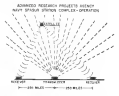
Detailed performance specifications in new electronic equipment/measurements capability system can be obtained by visiting Mission Research Laboratories, Inc., 1109 Loomis St., St. Louis, Mo.

Expansions, Changes In Avionics Industry

Applied Technology, Inc., is the name of a new firm in Palo Alto, Calif., which will specialize in very broadband microwave systems using traveling-wave and small beam-type tubes for electronic communications, radio altimeters and navigation systems. Company is headed by Dr. William E. Auer, president, and Peter D. Strain, vice president, both formerly with General Sciences.

Other recent changes and expansions in the avionics field include the following:

- **Acousticon Systems, Inc.**, will build a \$30 million research center in New York City. When this and other new facilities under construction are completed in July, 1960, the company will have a total of 516,000 sq. ft. with another half million square feet planned for final completion in the end of 1961.
- **DAC Magnetics Corp.** is the new name of the former Infection Motion Corp., Woodbury, N. Y. Company also reports the acquisition of Gary & Rubin, Inc., Rockville Heights, N. Y., which manufactures delay line transformers and films.
- **Texas Instruments** has formed a General Sciences and Instrument Division, to be



Satellite Tracking Net Established in Southern U. S.

Network of four stations for tracking satellites without active radio transmitters now stretches across southern portion of the U. S. One such link is at Joliet, Ill., where Spalder's station, developed by Office of Naval Research, tracks non-instrumented satellites while three other stations developed by Army Research Research Laboratories employ Doppler tracking techniques. Each Spalder site consists of a radio transmitter which produces a fine-tuned beam to illuminate satellites, and two receiving stations, located 250 mi. on either side, to receive energy reflected off the satellites. Reflected phase of reflected energy is used to establish satellite's position in space.



Elkhart antenna array employed for Spalder station is shown in aerial view (left) and ground view (right). First Spalder station, at Joliet, La., was completed last July, the last station at Elkhart, Ind., N. M. was finished in January. Data from stations are relayed directly to Washington, D. C., for analysis and reduction. The above satellite detection network is under the overall direction of AFOSR.



Height-Finding Radar

W. L. Merson Corp., New York, N. Y., will develop a height-finding radar system for the Federal Aviation Agency at its Air Traffic City N. Y., experimental center under NBT without contract. An Height-Finding Radar (AFHR), employing a fixed-focus 150 ft. high antenna will be designed to provide height information on aircraft up to a range of 50 mi. Complete test of the prototype system is scheduled for October 1960.

headed by Fred J. Agnew, vice president.

- **CBS Electronics** is now name of former CBS/Union Division of Columbia Broadcasting System. Division, which manufactures radios, televisions and computers, will build a new 150,000 sq. ft. semiconductor plant in Long Island.

• **Melpac, Inc.**, has opened a new 60,000 sq. ft. plant in the Shaker in Laurel, Md., south of Washington, D. C., housing the company 1960 to approximately 500,000 sq. ft.

• **Underwood Corporation's** Conga Division will erect a 25,000 sq. ft. plant near Ft. Walton, Fla., for development and manufacture of telemetry, radar and instrumentation, much of it for use in USAF's main Air Force Ground at Eglin AFB.

• **Ball Telephone Laboratories** will build a new \$20 million laboratory at Holmdel, N. J., for research in advanced communications. BTL currently has a research facility at Holmdel.

• **Shaw Engineering Inc.**, Fairfield, N. J., has purchased the radio tube, framer and inductor business of The Radio Laboratory, Elizabeth, N.J., which has been transferred to Shaw's New Jersey facilities.

• **Kennedy Co.** has started construction of new million dollar 100,000 sq. ft. facility across from present company headquarters in West Paterson, N. J.



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- 5 Installation is simple. Standardized parts bolt together—no welding or specialized equipment required!
- 6 Completely pre-stressed tanks require no painting or other upkeep!
- 7 Approved for military and commercial applications!



THE "AIR CURTAIN" PRINCIPLE IN A NUTSHELL
Horizontal blast is converted into a vertical air curtain blocking off both low and high level blasts.

VINNELL STEEL
IRVINDALE • CALIFORNIA

Write, we'll phone for complete details on the Vinnell-Lynnco Air Curtain Blast Fence.

FILTER CENTER

► **Space Vehicle Power Goals—Current** objectives of Army Signal Corps development of secondary power sources for satellites and space vehicles call for availability of a long-life 10-watt power source within a year, a 100-watt source within two years and a source in the laboratory stage by 1963.

► **New Space Cell Configuration—Army** Signal Corps is experimenting with a new configuration for measuring silicon solar cells to increase available exposed area and generate power. Solar cells will be mounted on surfaces of a hollow configuration which will be compressed during launch to remove space, subsequently be ejected and allowed to expand over the solar cell in orbit.

► **Reducing Tube Replacement Costs—Scientific** approach to planned tube replacement is being in some experiments developed by Arinc Research Corp. is expected to reduce in-flight failures and save perhaps up to 40% of the cost of expensive failures and maintenance involved in replacing failed tubes. The procedure does not involve complex record-keeping. Highlights are described in AFRC Letter No. 58-1-28 available from Aeronautical Radio Inc. 1750 "K" St. N.W., Washington D.C.

► **Private DMEI—Focus** is offering National Aeronautics Corp. to develop and lease DMEI equipment for general aviation. (NAV April 20, p. 14), Federal Aviation Agency's



Ferrite Device

New ferrite devices, using natural magnets, show size and weight to a fraction of former figures, according to Sperry Gyroscopic Electronics Co., which developed the technology. One 1-inch ferrite device is only 1/16 in. long and 1/16 in. wide, weight of grade silicon. Sperry says. The technique is being applied over a frequency band of 400 to 11,000 mc. Internal magnet also provides a more effective natural field than other external magnetic materials are stated.



Infrared Dome

Infrared dome, called the largest Ikhon area produced in one piece, has been delivered to Space Cooperation of America to North Air Development Center for an experimental program which will study, comparative ground and airborne studies, on the effectiveness of different infrared detectors. Ikhon is made of various materials which permit infrared radiation not to penetrate of 12 inches, the company says.

Branch of Research and Development achieved prepared designs, cannot be correct to provide maximum accuracy that the design might be modified and sold for less than \$1,150, an agency spokesman says. A total of 11 companies submitted bids. Prices in stated in dollars or 200-point per cent, starting at \$11 results, under terms of its \$291,000 contract.

► **Signed on the Dotted Line—Major** contract awards recently announced by various manufacturers include the following:

► **Benet Radio**, contract for more than \$150,000 from Navy Bureau of Aeronautics for VME communications systems.

► **Radio Corp. of America** awards a multi-million dollar contract from Navy Bureau of Ships for study and development of new communications systems for Polaris program, presumably to permit long-range communications to Polaris-carrying ships.

► **Sperry Gyroscopic Co.**, \$877,450 contract from Air Force for 50,000 type 3631 electronic tubes.

► **General Alouette** repairs contract from Lockheed Laboratories to investigate new communication techniques for solving and decoding several channels of voice or teletype under adverse propagation conditions. System concept is designated as "Kirkwood."

► **National Co., Molder, Mass.**, \$5.1 million contract from Navy for an advanced quantity of "no drift" radio transmitters.

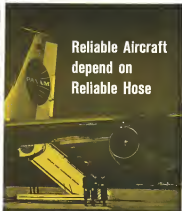


Photo on cover: Fluoroflex-T hose in use.



MODERN military jets have proven Fluoroflex-T (Teleflex) hose is rugged service. Now the fast new commercial structures use this same hose—for safety and economy.

Fluoroflex-T hose, with patented, specially compounded Teleflex-Telene, is non-springs—has no stiff or service life limit. Originated by Teleflex, Fluoroflex-T was the first Telene hose and it has been doing for five years on all types of ground and aircraft engines and on trucks. It is available with compression-type fittings or "Steel-Link" ramble fittings.

Always specify the hose with highest performance and capability—not only for safety's sake, but for savings as well. Send for details: Wren's Department 202, Bannockburn CORP., Bannockburn, Ill., New Jersey, Other Plants: Berkeley, Calif., Dallas, Tex.

"E. M., Pat. No. 2,833,328"

© Fluoroflex is a registered trademark, reg. U.S. Pat. & © Office in U.S. and a trademark for E.M. Fluoroflex hose.

Properties of high performance Fluoroflex hose materials.

Resistoflex

special CAPABILITIES



missile connectors & assemblies

Skill in application engineering, production facilities and experience gained in short or long runs, a proved reputation for reliability—these are AMPHENOL's special capabilities in missile components. The assembly illustrated above reflects these capabilities.

This assembly has four AN MS "E" connectors wired into a 83 contact shear-type connector and is being supplied in quantity for a production missile. Electrical connection between missile and ground support equipment is provided until the instant of launch when a 3500 pound maximum shear force shears all 83 contacts. All connectors are tested for optimum reliability.

Interstage connectors, umbilical breakaways, internal components and connectors for ground support equipment are now being manufactured for many missile projects. Inquiries on AMPHENOL's special capabilities in this field are invited.

AMPHENOL

CONNECTOR DIVISION

Amphenol-Bell Electronics Corporation, ELIZABETH 58, NEW JERSEY



with either internal or remote pressure sensing. Speed/pressure switch. Air burst temperature range is from -140 to +300°F. Supply air pressure range is from 100 to 1,000 psig at temperature from -140 to +300°F. Air flow capacity of the 1.25 in. unit is from 0.1 to 100 scfm.

Regulated pressure setting is from 10 to 300 psig.

Aerovac Controls Corp., 1788 New York Ave., Huntington Station, N. Y.

Rocket Engine Handler

Hydraulically actuated machine, designed for the Throckmold Company's redesigned inspection of solid propellant rocket engines.

Rocket engine is lowered into the machine, moved to the moving loca-



tion and moved and positioned so that all portions of the engine can be viewed. Discharge of the machine permit the inspection of 6,000 lb. engines, 5 to 10 ft. long and 36 in. in diameter.

Dames & Moore, Inc., 230 E. Ohio St., Chicago 11, Ill.

WHAT'S NEW

Publications Received:

Private Jet World—by C. L. Chandler, P. O. Box 212, Babylon, L. I., N. Y. 11704, N. Y. \$2.95, 46 pp. (Paper bound) Drawings and descriptive language show the pilot, flight dispatcher, operations officer and others concerned with flight operations the structure of the jet stream and how to fly it. A left hand and is included with the book showing the vertical axis section type of jet stream.

Revised Aircraft Structures—Fah Giba (A. R. L. Ltd., Davidson, Cambridge, England) \$7.95, 177 pp.

Forecast Meteorology—by Arthur Miller & M. Parn, Pub. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. \$7.95, 210 pp. A detailed explanation of the science of weather.

The Aerospace Directory of British Aerospace—Lough Press, Ltd., Basing Green Lane, London E. C. 1, 301 net (\$4.20), 639 pp.

This directory is an annual reference work which covers aerospace industry, aviation and civil, in the United Kingdom and throughout the British Commonwealth, including a biographical section of some 2,000 authors.

Civil Air Regulations and Flight Standards for Private-Aero Publications, Inc., 2162 Sunset Blvd., Los Angeles 26, Calif. \$2.50. Recent government changes in flight rules have been added to this new edition. A sample written test of the type a student pilot must pass to obtain a private pilot certificate is included along with Air Education requirements, Airport Traffic Control, and instructions on how to read weather reports. Color illustrations are included. The revision government section chart for the examination is provided.

Aircraft Directory of Canada—1969 Edition—Published by Aircraft, 341 Church St., Toronto 2, Canada. \$5.00, 184 pp. The contents of this directory include Canada's air transport industry, aviation industry, civil government departments & organizations, aircraft manufacturers, civil government departments & organizations, aircraft manufacturers, civil government departments & organizations, aircraft manufacturers, civil government departments & organizations.

NEW BENDIX MS-R ENVIRONMENT RESISTING ELECTRICAL CONNECTOR



This connector will accept 20 pin gold contact with MS-D-30000

This new connector answers the demand from the aircraft industry for a shorter, lighter and more reliable environment resisting connector. The new connector is designed primarily for other MS types and the Military has assigned it a new class letter & to assure incorporation of this better connector in all new designs.

An important reliability feature of the new MS-R connector is its "E" plug in the most complex part which provides for the best possible working and most positive inter-lead compression and assures complete performance compatibility among all types of MS-D connectors. Establishments of the MS-R connector in the "new class" military connector is testimony to the record of previous MS environmental resistant connectors using contact inserts as pioneered by the Division. In the Bendix® connector, wire seating is accomplished by an exclusive slippage rubber process which permits convenient wire threading and prevents travel over wire bundles.

Write for more complete information on this latest addition to the ever-growing family of Bendix electrical connectors.

Bendix

SCINTILLA DIVISION
DOWNEY, NEW YORK

Bendix
ELECTRIC CORPORATION

Export Sales and Service: Bendix International Division, 30-1, 4th St., New York 17, N. Y.

Bendix Military Division: Bendix Ltd., 100 Lancaster Rd., Weybridge, Surrey, England

FACTORY BRANCH OFFICES: Boston, Gold, Grand Rapids, Chicago, St. Louis, New Jersey, Dallas, Texas, Seattle, Washington, Washington, D. C.

AVIATION WEEK, May 15, 1969

111

TRUE PORTABILITY

is why one man can service aircraft
or missiles in minutes with Cornelius
ground support air compressors



Model 270027
7 SCFM — 130 psi



Model 200101
3.9 SCFM — 300 psi



Model 220030
5.5 SCFM — 260 psi



Model 1200409
3 SCFM — 340 psi



Model 1000100
4 SCFM — 300 psi



Model 1200430
3 SCFM — 390 psi

Cornelius ground support air compressors are light enough to be handled by one man but don't let this small size deceive you! When it comes to performance they provide pressures up to 3000 psi and air delivery up to 4 SCFM. Cornelius compressors are often the selected air service and complete jobs faster and easier than standard equipment. They are ideal for "retrofits" service because they are really and reasonably firm to installed aircraft.

A complete Cornelius ground support service system includes compressor, pressure regulator, oil filter, relief filter, relief valve, pressure gauge and high pressure hose. Pressure regulators, back pressure valve, pressure regulators and check-valves are optional. Cornelius engine driven, hydraulic or electric motor drive as well as turbine drive can be used to power Cornelius equipment. AE U.S. military services use Cornelius compressors. Aircraft, missile, flame chamber and underwater demolition support are a few of their current applications.

Cornelius also manufactures compression units, for servicing on your own military ground support units. In addition, a complete line of small industrial compressors up to 5000 psi (electric pressure) for G-24, lab work, production test work and maintenance are available.

For true portability, one man operation and reliability in a small, compact, fast and ground support compressors, talk with a Cornelius sales engineer or write today for more information.



THE **Cornelius** COMPANY
AERO DIVISION

504 - 27th Avenue N.E. • Minneapolis 21, Minnesota

Pioneers in pneumatic systems for aircraft.

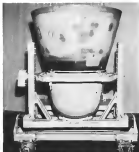


Discoverer II nose cone and fitting are attached to the Advanced Research Projects Agency vehicle, vehicles already. Nose cone involves an environmental package within a recovery capsule, an afterburner supporting a retrorocket, and the firing assembly.

Lockheed Assembles Discoverer II Nose Cone Unit



Environmentally capable (left) is placed in assembly, a capsule which contains parachute and booster when fully assembled (right). Lock head designed and fabricated around stage which carries the recovery capsule. Booster is a modified GSNP-Dragon They HBM.



Recovery capsule is attached (left) to afterburner. Fully assembled nose cone with fitting is in casting dolly at right. Discoverer II was launched April 11 from Vandenberg AFB, Calif. (AW April 20, p. 26). Re-entry capsule was opened and left in southern polar area.



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vibration test systems from



...the pioneer and leader in the field of vibration

**without E-W cooling units,
electronic gear
in this hut
would burn out
in minutes!**

The Ellis and Watts Model A-8 Unit that keeps this critical electronic gear cool has a cooling capacity of 9000 BTU's per hour. Without this vital cooling capacity the electronic equipment would burn itself out in a matter of minutes! Whenever electronic gear is used, it creates heat problems. And, in compact airborne test cells these problems are especially serious.

Designing and building specialized units to keep electronic gear cool is our business at Ellis and Watts. Units of any capacity, modifiability, control requirements or functions can be designed and built to any applicable military or commercial specifications. E-W Units will function profitably in any climatic conditions on earth.

For additional information on Ellis and Watts Model A-8 Unit for cooling electronic gear in airborne tests or similar installations, write for Bulletin #130-A.



ELLIS AND WATTS PRODUCTS, INC.
P. O. Box 22-A, Cincinnati 20, Ohio



INTERIOR of the G-21C demonstrator was designed by Hinton and Hinton of Ft. Worth Tex. View toward the cockpit shows dual passenger seats in the forward cabin plus a third place each along the right cabin wall at the rear. Floor can be equipped with rails

under or paint. It suits the low Lyingover 140 hp supercharged C80-404-B2C5 engine and low Hartzel ducted, full feathering, reversible, constant speed propeller. The aircraft

also has a propeller anti ice system with a 60 gal capacity.

McKinnon points out that the four reversible propellers make maneuvering on water easy and permit the pilot to compensate for currents and wind. The individually reversible blades allow the amphibian to tow alongside a float to assist passengers and cargo.

Diesel fuel has been installed to improve visibility.

None of the G-21C has been extended 175 in. and extended, and it has a glass fiber nose to accommodate radar. A speed rail is installed along the hull at the nose area to keep open main lines the windward and propeller. G-21C has a current, one price 1 in

McKinnon G-21C Specifications

Cruise speed: 4000 ft.	200 mph.
10,000 ft.	200 mph.
Climb	2,000 ft./min.
Range	8,500 mi.
Wing span (both extended)	36 ft. 10 in.
Length	35 ft. 7 in.
Height (to prop top)	14 ft. 6 in.
Empty weight	6,500 lb.
Gross weight	12,990 lb. land and water ideal
	12,000 lb. landing on land
Engines	4 Lyscoming supercharged C80-404-B2C5
	8100 140 hp on
Propellers	Hartzel three-blade, full feathering, reversible, 91 in. constant speed, hydraulically controlled.

windshield and has two picture windows in the passenger cabin.

Amphibian's landing gear has Goodrich wheels and hydraulic brakes. Main gear retracts into the hull and the tail wheel is also retractable. Fuel capacity includes two 175 gal main tanks and a 60 gal auxiliary. Fuel valves off valve, landing gear, alternate flaps and flaps are all electrically operated.

Conversion includes complete dual instrumentation, with dual vacuum gauges, dual electrical power source and alternate drive motor. Two power lines are incorporated with the dual main fuel tank and engine fueling system.

Amphibian's rubber boat, perfused with glass fiber instead of steel used to decrease engine noise and to increase the life of the amphibian.

Aircraft is structurally built to last the 12,500 lb. gross weight and it has a new floor structure and metal hull wings.

Jeinlet Heater

It is heated by a liquid 100,000 Btu heater. A number of smaller items complete the conversion.

Cost of conversion can be saved from the \$175,000 bid price by eliminating a number of floor items. For instance, a customer can save \$17,000 by choosing 235 hp Lyscoming normally aspirated engine instead of the 340 hp supercharged powerplant. For the extra seven hundred gals tank can be eliminated to shave \$1,000 off the price. Reductions in other areas are also possible.

In the future, McKinnon will offer Goodrich de-ice boots and a Collins Radio autopilot with the G-21C. They, among for these items in being done now.

Schweizer Expands Soaring School

Increased interest in amateur flight instruction has prompted Schweizer Aircraft Corp., Elmira, N. Y., to expand its training school curriculum for 1959 adding a new advanced soaring course which permits student glider pilots to qualify for Schenck "C" rating.

Three of the four courses offered by the micro-organized organization are planned for pilots with powered aircraft experience. The fourth is for beginners. Prices for the various courses: \$95 for professional pilot pilots, leading to a commercial glider pilot rating, which may be accomplished in two or three days, \$155 for the qualified private pilots, \$145 for the advanced soaring course and \$175 for the complete private glider pilot course.

More than 100 students enrolled in Schweizer's glider school last year, 49 commercial glider pilot ratings being

issued and 20 private pilots' ratings earned. Eight online pilots and a number of executive pilot ratings went through the school last year, the company reports. It notes that growing interest in amateur flight in this country is indicated by the fact that membership in the Soaring Society of America has doubled in the last two years.

USAF Utilizes U-3A At \$12.44 per Hour

Wicks, Kansas-based, operating costs for the Cessna U-3A within off the shelf costs part of the 1100 last year plane, based on up-to-date actual overhaul charge cost data, indicate that these airplanes are being operated for \$12.44 per hour-\$13.44 less than actual overhaul anticipated (AW Sept 29, 1958, p. 81).

The difference in the higher cost figure of \$13.88 per hour and most cost data is attributable to the fact that earlier overhaul figures were based on maximum allowable contract charges for replaceable items lacking sufficient or full overhaul charges at the time, and the current figure is based on actual overhaul costs, indicating that the actual data was conservatively prepared. Air Force commands are currently



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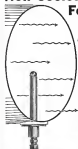
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...the pioneer and leader in the field of vibration

Non-Cooled Thermocouple For High Velocity Gas Streams

At Temperatures Up To 3600°F.



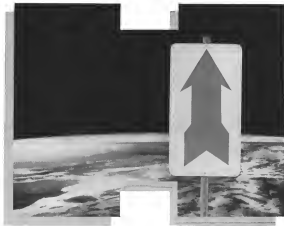
This new thermocouple can be used without wires or air cooling in the high velocity gas streams of jet engine afterburners and nozzles and rocket exhausts. It includes a ceramic shield and support tube. Conduction losses from cooling are eliminated and metal losses are negligible. Reactions between the probe and gas are prevented. In typical applications this probe indicated temperatures cycling from 1000 to 3600°F at a 1000 ft./sec. velocity for 30 hours with no failure. Temperature changes of 3600°F per hour caused no adverse effects. Conduction seal is Platinum 30%, Rhodium 70%, 650 Ohms in 3600°F, and Platinum Rhodium/Iridium in 3600°F. Contact Thermo Electric for details on this thermocouple in your needs.

Write for TDS-36-C

Thermo Electric CO., INC.
BAILEY BRIDGE, NEW JERSEY

In Canada:
THERMO ELECTRIC (CANADA) LTD.
Toronto, Ont.

Sign of the times



Southern California and Airforce from 143 miles up, photographed from a New Viking 12 rocket, fired from White Sands, N. M. Dark patch in lower left is the Gulf of California.

Gauging up... and out into space... this is one of the assignments of engineers in the laboratories at Hughes.

To meet the demands of the Space Age, a wide variety of new projects is being initiated. Here are just a few examples:

Space Ferry Systems—To provide the initial apparatus for space station assembly.

Communications Satellites—Unique packages for space satellite applications.

ALIKON—Air launched intermediate range ballistic missiles.

Global Surveillance Satellite Systems—To keep the world under surveillance.

Satellite Interception Systems—To destroy hostile satellites.

Motor Communications—Smoothing electronic highways.

Many technical programs at Hughes have proved themselves worthy for military equipment in the following areas:

Field Engineering	Systems Analysis
Communications	Component Engineering
Industrial Systems	Control Design
Digital Computers	Electron Tubes
Micro-wave Engineering	Industrial Systems
Semiconductors	Development Engineering

Write in confidence to Mr. E. A. Meier, Hughes Aircraft Company, 4441 Vanowen Street, Culver City, California.

Advanced Falcon guided vehicles are manufactured by the Hughes Industry in Taiwan, the largest electronics facility in all of Taiwan.

energy off centers to establish long range communications.

Futureistic Instrumentation Displays—Instrumentation displays for satellites and hypersonic vehicles.

Other Hughes activities are also participating in advanced Research and Development. Engineers at Hughes in Fullerton are developing new types of radar antennas which scan by electronic rather than mechanical means. Hughes Engineers in El Segundo develop test equipment which is as advanced as the equipment being tested. At Hughes Products, the commercial activity of Hughes, new ways have been found to cut offcuts into desired configurations...and storage tubes with 28" diameters have been developed.

Today Hughes offers Engineers and Physicists the chance to work on stimulating projects in a wide variety of fields. Never have the opportunities been more promising!

The World leader in advanced ELECTRONICS

HUGHES

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Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

Manufacturing Falcon and Air Force Personnel and various weapons systems, Hughes Aircraft Company now maintains in the partial vacuum operation of advanced Hughes equipment.



approach end of runway 3, about directly in line with the runway. Line of sight from the main wreckage in the end of runway 3 to its end was lost at 45 deg. The entire wreckage was confined in an area about equal to the length and span of the accident. It was determined that the wreckage struck the ground on its nose and the leading edge of the right wing such that wing suddenly forward so that its leading edge was parallel to the ground. The angle of impact was approximately vertical.

The main wreckage consisting of the major portion of the fuselage, empennage and wings, was found lying in its original position. Most of the aircraft was contained by the wreckage for which follow of ground impact. There was evidence that several engine explosions had occurred. These explosions were, caused by the ignition of isolated pockets of fuel which were burned after the aircraft struck the ground. It was apparent that some of the air craft struck the ground with considerable force. The lower half of the nose section, including the nose wheel fairing, was not found in its original position but was found in the ground.

The upper section which included the front cockpit, the antenna dome, baggage, cockpit seat, including control column, instrument panels, radio units, pilot seats etc., was separated from the air craft and contained along the back of flight 3. Various parts of this section were found at distances ranging from 35 to 60 ft from the main point of impact. Portion of the upper side of the aircraft from the nose wheel forward to station 337 were found approximately 35 ft from the point of impact.

Aircraft Components

The entire wreckage was found not only within the stated area but also aircraft components were found approximately in their normal positions relative to the structure of the aircraft. Both wings were severely damaged but not to a great extent of the wing structure was undisturbed. The baggage compartment of the wing was completely separated in place. The entire wing was not undamaged was gone except at wing section which points. The upper portion of the wing, which was lying adjacent to the ground forward of the upper down position of the aircraft, in some sections, was positively all that was left.

The push-back roller, a part of the control system of the aircraft, was not intact in some positions of these rollers, which are made of aluminum had rolled. The flight controls on the tail section were intact and functioned normally when tested. Found remains of all of the damaged controls failed to avoid any evidence of their malfunctioning prior to impact.

It was determined from examination of the flap system that the flaps were selected to the rising. Flaps were found in position that they were extended to this position. Most of the actuator gears were so badly damaged it was impossible to obtain readings, and the system which could read view of little significance.

The landing gear badly damaged and little could be gained from its examination. It was found that the main cabin area had

been hit and was destroyed through the entire, wreckage was destroyed, which were found, indicated that the cabin had been destroyed at the time of impact. From the rear pressure bulkhead forward there was little damage except from an external fire on the right side, caused by burning fuel. The top over head of the wing fairing and roller was bent 90 deg. to the left on impact with the ground. This damage was caused when the aircraft turned upside-down. The left horizontal stabilizer and elevator were essentially undamaged except for some staining. There was no evidence for damage to the aircraft structure back to the rear entrance door. From this point forward the damage was confined to the right side.

Geor Position

The nose gear and the main landing gear were determined to be in the "Down" position at the time of impact.

The main gear (Down, up), a part of the still running (back-halter) assembly, was found mounted in its normal position on the left side of the nose, with all the wheels still attached. The rubber foot that covers the wheel once a detector, of approximately half inch, which had been partially burned in an elevator. The rubber foot over the wheel plunger was still in position and was undamaged.

Four in checking the wheel (electrically, a number of indicators of the plunger were made but no visible indication of the wheel as it based on could contact of the points be felt. Subsequent inspection disclosed that although the opening plunger was in the withdrawn position the roller or magnetic mechanism, which supports the possible switch contacts, was in the position of a switch when the opening plunger is depressed. This position prevented the switch contacts associated with the still running current to be in contact at all times regardless of plunger position. Insured electrical circuits divided on one between these switches. However, during inspection, the roller of the magnetic group and both conducted by the National Bureau of Standards contacts did not between the detector contacts.

The models existing in operation are not built up in light and are closed upon each other by movement of the opening plunger. The roller mechanism is not in a position to be actuated. Upon becoming actuated the plunger is withdrawn, preventing the roller mechanism to be triggered by opening door. Therefore, upon the contacts and raising the still running current.

Magnet Position

It was found that the roller would indicate to normal when the lower magnet was released but would remain in the depressed position when operated with the magnet mechanical. A similar behavior was noted with the main gear magnet.

Upon returning the magnets to their original position the switch operated properly and continued to do so. It was also determined that the wiring out of the still running system was installed April 23, 1957 and was not released prior to the accident.

In addition to the examination of the

FLIGHT DATA AND CONTROL ENGINEERS

Com new position in system discussion at The Green Caps room

High level engineers in the design and development of system also have not available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA, SYSTEMS AND CONTROLS A wide range of opportunities exists for creative R & D engineers having specialized experience with control systems such as transducers, flight data computers, black boxes, servo mechanisms, circuit and scaling computer designs, analog transmitters, computers and various relays.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS Requires engineers with experience in accurate training in the advanced design, development and application of magnetic indicators and transmitters.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS DESIGN ANALYSIS Requires engineers capable of performance analysis throughout preliminary design work ability to prepare and conduct related projects.

4. DEVELOPMENT Requires engineers skilled with the analysis and synthesis of dynamic systems including design of automatic mechanisms in which low friction freedom from vibration effects and compensation of dynamic response are important.

5. PROPOUL AND QUALITY ENGINEER For experienced personnel, practical and quality analysis and report writing capabilities. These jobs require electronic, electrical or mechanical experience required.

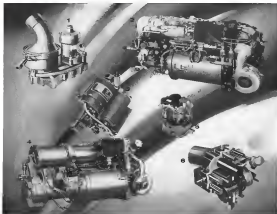
Forward resume to:

Mr. G. D. Bradley

THE GARRETT CORPORATION
1001 S. Lawrence Rd.
Van Nuys, Calif. 91411

Garrett
Aircraft Manufacturing Corp. - Los Angeles
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DELIVERED - thousands of missile engine APUs



1. Solid propellant—hydraulic output 2. Liquid propellant—hydraulic and electric output 3. Solid propellant—electric and mechanical drive output 4. Liquid propellant—hydraulic and electric output 5. Solid propellant—hydraulic, electric and electric output 6. Solid propellant—hydraulic, electric and electric output

AirResearch has designed, developed, manufactured and delivered thousands of missile auxiliary power units (APUs). Extremely reliable and lightweight, these various solid and liquid motor-propelled APUs are completely self-contained, requiring no gas or gas system. Designed to maintain space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several tests pic-

tured above provide hydraulic, electrical and/or moving surface control depending on the customer's requirements. Delivered thrust ranges from 1.2 to 25 k.p. per hot gas operating at altitudes from 30 seconds to 20 minutes. Electrical regulation is maintained actively as 40%. AirResearch advances in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing

storing surface activation systems. These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AirResearch needed for quick and efficient quantity production of complex APU systems. AirResearch is the world's largest and most experienced manufacturer of lightweight thermomechanical—the key component of all APU systems. Your requirements are invited.

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Typical Allison Pump

Type 40-A or 42-B rated capacities at 2200 rpm (70 to 450 gph). Starts operating on board. Simple with virtually no maintenance. 24 hr. Type P-10 available without relief valve for use as transfer pump.

TITAN Positive Displacement Rotary Fuel Pumps

Among the best-known "demonstrators" which last summer in detail demonstrated the TITAN FUEL PUMPS have long been specified as required equipment in the aircraft of thousands of military, naval, and civilian aircraft. Titan Pumps have been selected for inclusion in inventory, maintenance, and repair. High quality and reliability. Available in various sizes. (See advertisement for a complete pump description and list of available pump sizes.)



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PROFESSIONALS

TITAN PUMP AND
ENGINEERING CORP.
New, Michigan

Forces the fuel through the pump. Fuel is a vital part of the engine. Titan Pump is a vital part of the engine.

can, gear events the National Bureau of Standards conducted static and dynamic acceleration tests on four turbine engines and the test results indicate the extreme reproducibility of the new gear units and function below the level of stress.

As long as gears and their respective propellers were housed in the wing space in a straight line and were in direct contact position relative to their respective attachment points on the aircraft, No. 1 and 4 engines were based on the ground to a depth of about 10 ft. No. 2 engine had direct a ground pile and had proceeded into the ground to a lesser depth. All engines had covered nose doors which also were positioned about 19 to 20 deg. with respect to the horizontal. The engine supported from the aircraft at three separate points and aligned directly and at a angle of impact forces were damaged in varying amounts.

The underside case of all engines were broken through the separation of the fuselage and components. These parts were found to be completely free to the aircraft and their respective engines. All engines were damaged in ground by following impact. There was no structural damage to the engine associated with the flight test. Engines attached were intact with a maximum force position prior to impact could not be determined.

Twelve engine tests were broken in two of the second test engine tests. Vibration after that became in with or other because throughout the engine test and down the engine of operational defect.

Also, each propeller is fitted with a switch that is activated when the propeller blades move into the ground but propellers were found to be completely intact and the ground damage was not as extensive as the aircraft damage.

During the investigation a number of witnesses located on and around the aircraft were interviewed. While the aircraft was in complete agreement as to what they saw, it is general it was as follows. Some actually are the cause of the aircraft in the aircraft, but some did not see the impact and the cause of the impact. They said that the aircraft was seen to be in the aircraft at the time of the impact. The aircraft was seen to be in the aircraft at the time of the impact. The aircraft was seen to be in the aircraft at the time of the impact.

The first propeller was subjected to the ground damage to the nose section of the aircraft. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged.

The propeller rotating parts position were subjected to the ground damage to the nose section of the aircraft. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged. The propeller blades of the first engine were found to be completely damaged with No. 1 being the most damaged.

Propeller Data

The four blades of the propeller were in position from 5 to 10 deg. to 15 deg. to 20 deg. to 25 deg. to 30 deg. to 35 deg. to 40 deg. to 45 deg. to 50 deg. to 55 deg. to 60 deg. to 65 deg. to 70 deg. to 75 deg. to 80 deg. to 85 deg. to 90 deg. to 95 deg. to 100 deg. to 105 deg. to 110 deg. to 115 deg. to 120 deg. to 125 deg. to 130 deg. to 135 deg. to 140 deg. to 145 deg. to 150 deg. to 155 deg. to 160 deg. to 165 deg. to 170 deg. to 175 deg. to 180 deg. to 185 deg. to 190 deg. to 195 deg. to 200 deg. to 205 deg. to 210 deg. to 215 deg. to 220 deg. to 225 deg. to 230 deg. to 235 deg. to 240 deg. to 245 deg. to 250 deg. to 255 deg. to 260 deg. to 265 deg. to 270 deg. to 275 deg. to 280 deg. to 285 deg. to 290 deg. to 295 deg. to 300 deg. to 305 deg. to 310 deg. to 315 deg. to 320 deg. to 325 deg. to 330 deg. to 335 deg. to 340 deg. to 345 deg. to 350 deg. to 355 deg. to 360 deg. to 365 deg. to 370 deg. to 375 deg. to 380 deg. to 385 deg. to 390 deg. to 395 deg. to 400 deg. to 405 deg. 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MAGNETOHYDRODYNAMICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY



MAGNETOHYDRODYNAMICS. Lockheed's 3rd Annual Symposium* on this reported new field—which deals with the behavior of conducting fluids in magnetic fields—attracted physicists from all over the world. As portrayed by the artist, man's earliest experiments with magnetic fields involved the use of the ancient lodestone. Solar phenomena are a dramatic example of such forces under investigation today.

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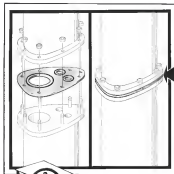
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*Copies of the proceedings of the first two symposia were published by the Stanford University Press, Palo Alto, Calif. and are available in each issue. Details of this year's symposium will be published shortly by the same house.



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Valve seat and a total of more than 10,000 lb. in all models. He was leaves to be a careful and conservative pilot.

ANALYSIS

From all available evidence the final failure of the aircraft structure, its fuel system, and powerplants were a proper opening condition given to the crash. Although the flight control lockage could not be measured in these respects because of damage caused by the release for those portions remained about no evidence of a control malfunction.

The Dynamic risk time area the still warning system when the aircraft was alone was found to be malfunctioning after the crash. Examination of the risk and acquisition tests conducted on these systems indicate strongly that the failure rate could not be the cause.

In the course of its investigation the board was provided test data by Victory Aerospace, Ltd., concerning the effects of heat upon the Dynamic risk, and it was suggested that the malfunction of the risk or risk could have been the result of its being heated in the fire that followed its impact. The physical evidence indicates that the aircraft was subjected to crash for long enough the board notes that the behavior of neither board in location tests does not provide with the behavior of the subject system. The system switches active failed in function in all other bearings as at least risk, however, significantly shows the subject system, following its normal and reasonable at all aspects, especially regarding with normal testing, action.

Similar malfunctioning of Dynamic switches in test experiments by Capital Airlines in normal flight operations without the switches being being subjected to high temperatures. One such malfunctioning switch was not properly checked by a CAVI investigation as it was unusual for the aircraft. It had been removed as an "unreliable" unit. This switch suddenly failed in operation in the engine when the engine was reduced under it was given a deep blow with the head. Later on, without having been tested in it was seen, the switch was found to operate normally and after quiet examination of the National Bureau of Standards data to further any appropriate action for an earlier malfunction.

Impending Still

The risk shaker is designed to wear the pilot in an impending stall and this is accomplished by means of the ability of the device to sense the control of attack during an approach to a stall. The device is further designed to break the pilot as an active warning under all light conditions and to indicate during transport flight. Under the conditions of flight Capt. Hall is believed to have experienced this night, had the shock shaker been operating. The warning should have been approximately 15-20 before the "2" band. During the flight tests a high rate produced subsequent to the public hearing the study of the board of 10 days did not have the shock shaker in operation. Therefore the above figure is an approximate based on actual



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The detection unit of the stall warning system had been updated sometime prior to this flight. In view of the fact that this unit was not calibrated by flight testing prior to the flight, there is no assurance that an adequate stall warning would have been given, even had the Dornier switch functioned normally.

Risky Path

During the investigation, it was determined that the second white flying squirrel (hereafter referred to as male) was not alone, the pair probably mated and arrived somewhere, leaving the ground as it was a darkened position while on a north-south heading. There was a number of larch which point to the roadhouse. The open terrain presented a clear, an unobstructed look 87.9 high 150 ft behind the structure and in line with the flight path of the second. While the last fact the tree was not damaged does not necessarily indicate a strong impact angle of the second at 21 deg. Other larch which followed, went to a sharp impact angle and

There were no needles, cotton, or paper in the project except where the students had.

2. There was no evidence of cartwheeling behaviour or of the screen striking the ground with an horizontal velocity in any manner which would produce carriage surfer with a large scale in fact, the work-use was confined to a small area.

¹ The cuspids were buried oriented about 100 m (or less) in the ground. No. 1, 2, and 3 at a 45-deg angle and No. 4 at a 70-deg angle.

† The right wing leading edge had reached the ground next to and extending from the No. 4 engine for a distance equal to the postulated loss that equated to the wing tip.

³ The same year showed side mirror damage and no impact marks were found on it except on the top of the link.

6 The most landing gear was found extended locked and undamaged by impact.

7. The lowest floor beams (rows 22 to 112) collapsed to form a mass 38 in. deep, each of these beams was displaced only two inches higher than the next upward beam. This entire mass was located directly under No. 112 truss.

Accepted Position

The data that the aircraft was found started to explode in this manner. The device indicates that it struck the ground in a vertical or near vertical position and that the rotational forces present during the descent caused it to combine into an air back with the engines containing the ground in a single large body. The vertical motion is substantiated by the fact that the propeller blades were bent, the landing door opened at all low propeller speeds, the comparable lift damage to the nose gear strut (the crushing downward of the outer eight feet of the leading edge of the left wing into two separate lobes), the nature of the damage to the wind deflector, the nature of the damage to the control pedestal and fuselage skin.

Also, by extrapolation of certain data

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from the NACA (NATH) "Attachments to Transporter-Carrier" agreement was found to exist between these results and the Board's conclusions with respect to the angle of impact.

In an effort to determine the cause of the sudden pitch-up and steep descent, considerable effort was given to the propellers and their related systems with particular significance placed on the possible movement of the blades before the final five pitch steps during the approach. It has been determined that such a malfunction of one propeller, shortly after the eighth five pitch step was achieved, and permitting the blades to move to a low pitch would not initiate an abrupt sea gross such as occurred on this instance. Furthermore, the electrohydraulic stop as well as various propeller operating characteristics provide safeguards which preclude such a malfunction. The change of such an event, creating a hazardous situation. The conditions outlined the result in three portions of the propeller system that are common to all four propellers.

The system, which permits withdrawal of the eighth five pitch steps after the seventh is on the ground, is so arranged that a double fault must exist to accomplish this function in flight. Furthermore, the removal of such a double fault would be subjected to varying loads in the cockpit and passenger's aircraft to prevent such a development would have been and able to the run. In addition, test crews to detect a single fault in either the jet or air regulator side of the control is provided. Consequently, it is considered that the propeller eighth five pitch step could clearly provide protection against withdrawal of the steps to such a degree that unwanted withdrawal did not occur in this instance.

Propeller Drag

The inherent propeller drag operating characteristics are such that a considerable degree of pitch/turn against momentary drag during approach is provided. This is true in that the propeller is being governed according to engine power and air speed throughout the approach. High drag is developed only at low speeds, 165 ft or less and with throttle completely retarded. The blade angle would remain above the eighth five pitch step (44) as high as 11,000 rpm with power applied. It is believed therefore that the inherent operating characteristics of the propeller would provide any high drag of action occurring during the final phase of a normal approach. This has been substantiated by both test flights and propeller wind tunnel tests.

Since it was evident that there was no indication as to the cause of the propeller and aircraft situation, the investigation was focused upon the operational phase of this accident.

There is no question of the crew's contribution to the accident. Their position and first officer had considerable flying time in the aircraft and both were properly certified by the CAA. As stated before, Capt. Hoff was given by the crew, due to him and by the CAA to be a careful and conservative pilot.

From the evidence it was learned that



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the downward lag of the traffic pattern was less close in. It was also revealed that the aircraft when on the last leg flew beyond the extended centerline of the run way and that a steep left turn in the form of an "S" was made for emergency. Some of the estimates said that this behavior the engine stopped a level altitude increase early on final, and that this position was followed by a sharply nose high attitude and then a vertical dive to the ground.

While the probability noted that the people flying around into the ground the, which position during flight, the possibility that the aircraft might not crash, was noted. Many flight tests have been made of the stall characteristics of the aircraft in level flight and during turns under three conditions: normal maneuvers have been carried out. Also, the various stall characteristics of the airplane in three air modes are not serious and known is no with made with little loss of altitude. Therefore it seems unlikely which that a stall occurred from a level flight attitude. However, if an unexpected stall occurred

during a steep turn at any altitude below 1,000 ft. a safe recovery might be impossible.

A study of the stall test showed clearly that with the stall warning device functioning the pilot should avoid a warning of stall, stall in sufficient time to recover to normal action.

However, with this device functioning and with the aircraft in steep turning flight the warning and the "A" break occur about simultaneously.

While tests indicated that the aircraft could be controlled within one minute with all conditions tested it is also true, that a fully developed stall was never predicted. Further, the pilots who flew throughout these stall tests have considerable experience in flight test operations and were each individual test not carefully planned, there was never a chance of surprise. Everying the stall to occur the pilots was able at all times to prevent the stall from reaching dangerous proportions. From previous tests made by the manufacturer it was known that when a stall occurs during a

steep turn, the aircraft tends to roll to the outside of the turn "over the top" and "under a spin" on the outside.

The approved Flight Manual for the aircraft defines the stall as that condition of flight when the lift coefficient has reached its maximum value (C_{Lmax}). It further states that if the angle of attack is increased beyond this point a wing drop and a nose down pitch cannot be prevented. Should an aircraft be made to correct the roll in a positive stall by use of aileron alone and without modification forward most part of the curved column the wing drop can be large (greater than 90 deg.), pitch roll associated with a large change in heading and a considerable loss of height.

Training Program

Because of the conditions described it appears that the company's V-6000 training program (which is dependent upon the dissemination of essential information to all pilots relative to the importance of the stall warning device with respect to adequate training and the design of

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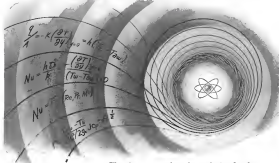
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